

**60% Design
Specifications**

**6217 Wilson Boulevard
and 5104 118th Street
Master Pump Station
Improvements**

February 2020



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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Work performed by Owner.
5. Multiple Work Packages.
6. Work under Owner's separate contracts.
7. Future work not part of this Project.
8. Owner's product purchase contracts.
9. Owner-furnished/Contractor-installed (OFCI) product.
10. Owner-furnished/Owner-installed (OFOI) products.
11. Contractor-furnished/Owner-installed (CFOI) products.
12. Contractor's use of site and premises.
13. Coordination with occupants.
14. Work restrictions.
15. Specification and Drawing conventions.
16. Miscellaneous provisions.

- B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.
2. Section 017300 "Execution" for coordination of Owner-installed products.

1.3 DEFINITIONS

- A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.4 PROJECT INFORMATION

- A. Project Identification: 180-45 Wilson Master Pump Station Rehabilitation and 180-47 118th St. Master Pump Station Rehabilitation

SECTION 412213.13 - BRIDGE CRANES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Bridge crane systems.
- B. Related Requirements:
 - 1. Section 055000 – Metal Fabrications
 - 2. Section 099010 – Shop Priming
 - 3. Section 099100 - Painting
 - 4. Section 262923 - Variable-Frequency Motor Controllers: Hoist and Trolley drives.
 - 5. Section 400593 - Common Motor Requirements for Process Equipment: Electric motors and accessories normally supplied as part of equipment assemblies.

1.3 DEFINITIONS

- A. Runway: Structural supporting system attached to or part of building/structure to support bridge wheels.
- B. Bridge: Part of traveling crane consisting of supporting girders, end trucks/trolleys, wheels, and drive mechanism, carrying trolley-mounted hoist; of single- or double-girder construction. Bridge mobility by electric motor drive or hand chain drive.
 - 1. Top-Running Crane: Traveling crane bridge running on top of support girders.
 - 2. Under-Running Crane: Traveling crane bridge suspended below the crane runway; also known as underhung crane.
- C. Hoist: Electric motor or manually powered hoist with load hook to raise and lower a freely suspended load. Hook supported by one or more wire rope strands that reel from a drum mounted on hoist, or by one or more strands of metal chain. Standard headroom or close headroom construction.
- D. Pendant: Hand-operated controller for bridge, trolley, and hoist that hangs from the crane by a cable or portable.
- E. Trolley-Mounted Hoist: Assembly consisting of a wheeled trolley with electric or manual drive that moves along bridge girder(s), supporting hoist.
 - 1. Top-Running Hoist: Hoist trolley running on top of bridge girders

2. Underhung Hoist: Hoist trolley suspended from bridge girder(s)

1.4 PREINSTALLATION MEETINGS

- A. Section 013100 - Administrative Requirements: Requirements for preinstallation conference.
- B. Convene minimum [**one week**] [<_____> **weeks**] prior to commencing Work of this Section.

1.5 ACTION SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 1. Manufacturer catalog information for rail, trolley, hoist, motors, controls, description of operation, crane capacity, equipment layout, and dimensions including hoist coverage limits.
 2. Equipment data sheets for hoist selection indicating capacity, lift distance, lift speed, motor data, weight, dimensions, and materials of construction.
 3. Equipment data sheets for hoist trolley selection indicating capacity, speed, motor data, dimensions, weight, and materials of construction.
 4. Equipment data sheets for bridge trolley selection indicating capacity, speed, motor data, dimensions, weight, and materials of construction.
 5. List of manufacturer's recommended spare parts.
- C. Shop Drawings:
 1. Dimensional drawings and details crane and runway, including clearances, principal dimensions, details of structural connections, and component details.
 2. Erection drawings.
 3. Support details and loads at each support.
 4. Control panel layout, location, control schematics, and wiring diagrams.
 5. Bill of materials of crane components.

1.6 DELEGATED DESIGN SUBMITTALS:

1. Submit signed and sealed design calculations and assumptions for:
 - a. Sizing of bridge girders and supports.
 - b. Selection and sizing of hoist brakes.
 - c. Sizing of bridge and trolley brakes.
 - d. Tabulation of crane rail stop load reaction on the structure.
 - e. **[Seismic analysis of bridge girders and end trucks.]**

1.7 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate:

1. Certify that products meet or exceed standards referenced herein.
 2. Certify that final installation meets or exceeds standards referenced herein and standards of each manufacturer providing components for the system.
- B. Test and Evaluation Reports:
1. Mill Test Reports: Indicate for bridge.
 2. Inspection and Rated-Load Test Reports: Indicate according to ASME B30.2.
 3. Crane certification documentation.
- C. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- D. Source Quality-Control Submittals: Indicate results of [shop] [factory] tests and inspections.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- F. Qualifications Statements.
1. Submit qualifications for manufacturer, installer, and licensed professional.
 2. Submit manufacturer's approval of installer.
 3. Welder certificates: Submit certifications of welders and welding procedures employed on Work verifying AWS qualification within previous 12 months.

1.8 CLOSEOUT SUBMITTALS

- A. Section 017700 - Execution and Closeout Requirements
- B. Project Record Documents:
1. Record schematic, wiring, and layout information for crane and radio controls.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 017823 – Operation and Maintenance Data
- B. Spare Parts:
1. Furnish following spare parts for each bridge crane:
 - a. [One] <_____> complete set of linings for each type and size of brake.
 - b. [One] <_____> set of collector shoes.
 - c. [One] <_____> wire rope with end fittings.
 - d. [One] <_____> NiCad battery with battery charger.

1.10 QUALITY ASSURANCE

- A. Design and Fabrication: Comply with the following:

1. AISC 325, Steel Construction Manual
 2. ANSI MH27.1 Specifications for Patented Track Underhung Cranes and Monorail Systems
 3. ASME B30.10 Hooks
 4. ASME B30.11 Monorails and Underhung Cranes
 5. ASME B30.16 Overhead Underhung and Stationary Hoists
 6. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 7. NEMA ISC 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
 8. NEMA ISC 8 Application Guide for Industrial Control and Systems Crane and Hoist Controllers
 9. OSHA 1910.179 Overhead and Gantry Cranes
 10. OSHA 29 CFR 1926, Subpart N
 11. [ASME HST-1, Performance Standard for Electric Chain Hoists]
 12. [ASME HST-2, Performance Standard for Hand Chain Manually Operated Chain Hoists]
 13. [ASME HST-4, Performance Standard for Overhead Electric Wire Rope Hoists]
 14. [ASME HST-5, Performance Standard for Air Chain Hoists]
 15. [ASME HST-6, Performance Standard for Air Wire Rope Hoists]
 16. [ASME B30.17 Cranes and Monorails (with Underhung Trolley or Bridge)]
 17. [CMAA 74]
 18. [ASME B30.2]
 19. [CMAA 70]
- B. Installation and Start-Up: Comply with:
1. OSHA 1919.71 Unit Proof Test and Examination of Cranes
 2. ASME B30.16
- C. All components to be UL listed where UL listed components are available.
- D. Perform Work according to <_____> standards.
- E. Maintain <_____> [**copy**] [**copies**] of each standard affecting Work of this Section on Site.

1.11 QUALIFICATIONS

- A. Manufacturer:
1. Company specializing in manufacturing products specified in this Section with minimum [**three**] <_____> years' [**documented**] experience.
 2. Member of the Hoist Manufacturers Institute
 3. [Member of the Monorail Manufacturers Association.]
- B. Installer: Company specializing in performing Work of this Section with minimum [**three**] <_____> years' [**documented**] experience [**and approved by manufacturer**].
- C. Licensed Professional: [**Professional engineer**] <_____> experienced in design of specified Work and licensed [**at Project location**] [**in State of** <_____>].
- D. Welders: AWS qualified within previous 12 months for employed weld types.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.13 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.14 WARRANTY

- A. Section 017700 - Execution: Requirements for warranties.
- B. Furnish [**five**] <_____>-year manufacturer's warranty for bridge cranes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Crane systems: Whiting Corp., American Monorail, Inc., ACCO Loudon Systems, or equal.
- B. Hoist equipment: Yale Hoists, Coffing Hoists, Harnischfeger, Wright, Shaw Box, or equal.
- C. Bridge Crane Systems Assemblers: Capco Crane and Hoist, Platnick Steel and Engineering, The Cooke Corp, or equal.
- D. Substitutions: [As specified in Section 016000 - Product Requirements] [Not permitted].
***** [OR] *****
- E. Furnish materials according to <_____> standards.

2.2 Performance and Design Criteria Crane [BC-1] <____>:

- A. Location: <____>

- B. Service Class: [C]<_____>.
- C. Environment:
1. **[Indoor]** **[Outdoor]**,
 2. [Unclassified] [Class I, Division <1> <2>, Group D].
- D. System Capacity: <_____> **tons** (<_____> **kg**).
- E. System Electric Power Supply: **[480 Volt, 60 Hz, 3 Phase]**
- F. Runway: [Provided under this Section] [Provided under <Structural>. Ref Section _____]
1. [Steel beam I-beam or specially fabricated steel sections supported by building structure]
 2. [Top mounted ASCE crane rail.]
 3. [[Standard steel structural beam] [specially fabricated steel sections] with hanger supports from building structure]
 4. Nominal span between supports: <_____> **inch** (<_____> **mm**)
 5. Runway reach (floor to underside of runway beam): [<_____>] [As shown on Drawings]
- G. Bridge:
1. Type: **[Top]** **[Under]**-running
 2. Construction: **[Single]** **[Double]**-girder.
 3. Bridge Capacity: <_____> **tons** (<_____> **kg**).
 4. Bridge Drive: [Manual] [Geared][Electric]
 5. Drive Type: [Single with cross shaft] [Dual on each end truck]
 6. Bridge Speed: **[Single]** <_____> **fpm** (<_____> **m/min**) **[Two]** <_____> **fpm** (<_____> **m/min**) **[Multi-speed]** <_____> **fpm** (<_____> **m/min**) Max].
 7. Bridge Drive Power: <_____> **hp** (<_____> **kW**)
 8. Bridge Motor: [TEFC] [TENV] [explosion proof], [single speed] [two-speed] [variable speed]
 9. Electrification: [Conductor Bar] [Festoon] [Cable Reel]
- H. Main Hoist:
1. Configuration: [Underhung] [Top Running]
 2. Headroom: [Close] [Standard]
 3. Hoist Type: [Manual chain] [Electric chain] [Electric wire rope]
 4. Hoist Service Class: [H1] [H2] [H3] [H4] [H5]
 5. Reeving: [Single] [Double]
 6. Hoist Wire Rope Material: **[Type 316 stainless steel ASTM A580/A580M]** [carbon steel **A1023/A1023M**].
 7. Hoist Suspension: [Lug mount] [Hook mount] [Trolley]
 8. Hoist Capacity: <_____> **tons** (<_____> **kg**) [As indicated **on Drawings**]
 9. Hoist Lift Distance: [<_____> **feet** (<_____> **m**)] [As indicated on Drawings]
 10. Maximum allowable headroom: [<_____> **feet** (<_____> **m**)] [As indicated on Drawings]

11. Hoist Lifting Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max].
 12. Hoist Motor: [TEFC] [TENV] [explosion proof], [single speed] [two-speed] [variable speed]
 13. Hoist Motor Power: < _____ > hp (< _____ > kW)
 14. Trolley Type: [Integral to hoist] [Hook mount] [Lug mount] [Separate tractor trolley]
 15. Trolley Drive: [Plain (manual)] [Geared (manual)] [Electric]
 16. Trolley Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max]
 17. Trolley Motor: [TEFC] [TENV] [explosionproof], [single speed] [two-speed] [variable speed]
 18. Trolley Drive Power: < _____ > hp (< _____ > kW)
 19. Electrification: [Conductor Bar] [Festoon] [cable reel] [tag line]
 20. Hoist/Trolley Control Enclosure: NEMA 250 Type [1] [4] [4X] [7] < _____ >.
- I. Auxiliary Hoist:
1. Configuration: [Underhung] [Top Running]
 2. Headroom: [Close] [Standard]
 3. Hoist Type: [Manual chain] [Electric chain] [Electric wire rope]
 4. Reeving: [Single] [Double]
 5. Hoist Wire Rope Material: [Type 316 stainless steel ASTM A580/A580M] [carbon steel A1023/A1023M].
 6. Auxiliary Hoist Capacity: < _____ > tons (< _____ > kg)] [As indicated on Drawings]
 7. Hoist Suspension: [Lug mount] [Hook mount] [Trolley]
 8. Auxiliary Hoist Lift Distance: [< _____ > feet (< _____ > m)] [As indicated on Drawings]
 9. Maximum allowable headroom: [< _____ > feet (< _____ > m)] [As indicated on Drawings]
 10. Auxiliary Hoist Lifting Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max].
 11. Auxiliary Hoist Motor: [TEFC] [TENV] [Explosionproof], [single speed] [two-speed] [variable speed]
 12. Auxiliary Hoist Motor Power: < _____ > hp (< _____ > kW)
 13. Trolley Type: [Integral to hoist] [Hook mount] [Lug mount] [Separate tractor trolley]
 14. Trolley Drive: [Plain (Manual)] [Geared (Manual)] [Electric]
 15. Trolley Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max]
 16. Auxiliary Trolley Motor: [TEFC] [TENV] [Explosionproof], [single speed] [two-speed] [variable speed]
 17. Auxiliary Trolley Drive Power: < _____ > hp (< _____ > kW)
 18. Electrification: [Conductor Bar] [Festoon] [Cable reel] [Tag line]
 19. Hoist/Trolley Control Enclosure: NEMA 250 Type [1] [4] [4X] [7] < _____ >.
- J. Control Panel:
1. Construction:

- a. NEMA 250 Type [12] [4X] [7] <_____>.
 - b. Single-point power connection and grounding lug.
 - c. Location: Factory mounted on crane bridge.
2. Limit Switches:
 - a. Description:
 - 1) Automatically stop hoist motion when block reaches its highest position.
 - 2) Prevent trolley and bridge from striking bumpers.
 - b. Comply with NEMA ICS 2.
 - c. Enclosures: Comply with NEMA 250 Type [12] [4X] [7] <_____>.
 - d. **[Furnish minimum of one spare isolated set of normally open and normally closed contacts.]**

K. Controls:

1. Description: Push-button pendant station [and radio remote control, only one of which may have control at any given time as selected by a master switch].
2. Comply with NEMA ICS 8 and CMAA 70/74.
3. Push-Button Pendant:
 - a. Location: [Suspended from trolley mounted hoist] [Suspended from fixed location on bridge with festoon control connection to hoist/trolley] [Wall mounted with hard wire and festoon control connection to bridge and hoist].
 - b. Elevation: [Fixed suspension [4] <_____> feet ([1.2] <_____> m) above operating floor.] [Pendant Reel: Furnish pendant reel with cable to reach to [4] <_____> feet ([1.2] <_____> m) above all floor levels traversed by crane.]
 - c. Controls:
 - 1) Key operated POWER ON-OFF switch
 - 2) POWER ON light
 - 3) RAISE /LOWER hoist control
 - 4) LEFT/RIGHT trolley control
 - 5) FORWARD/REVERSE bridge control
 - 6) Limit switch BYPASS button
 - 7) Master Switch: To select between pendant and remote radio control.
 - 8) [Speed control for functions incorporating [two-speed] [variable speed] drive]
4. Remote Radio Control:
 - a. Type: Portable.
 - b. Batteries: Rechargeable NiCad.
 - c. Controls:
 - 1) Key operated POWER ON-OFF switch
 - 2) POWER ON light
 - 3) RAISE /LOWER hoist control

- 4) LEFT/RIGHT trolley control
- 5) FORWARD/REVERSE bridge control
- 6) BATTERY MONITOR light.
- 7) Blue light under crane to be energized and visible from every direction whenever crane is operated by radio control.

d. Operating Frequency:

- 1) Comply with [FCC Part 15] <_____>.
- 2) Bandwidth: <_____> MHz to <_____> MHz.

2.3 COMPONENTS

A. Electric Motors:

1. As specified in Section 400593 - Common Motor Requirements for Process Equipment.
2. Comply with CMAA 74 and MH27.1

B. Runway track

1. [Patented track continuously welded high-carbon steel with raised tread.] [Steel structural beam [<specify>]]
2. Ends: Factory prepared.
3. Comply with CMAA 74 and MH27.1
4. Bolted trolley stops at every open end.
5. Provide end stop limit switch tripping bars and fasteners.
6. Provide all additional steel supporting members required for support of monorail runway from structure

C. [Manual Chain Hoist:

1. Comply with ASME HST-2, Service Class 1.
2. Brake: Mechanical type.
3. Provide overload limiting device
4. Chains:
 - a. Type: **Welded link**.
 - b. Material: [Steel] [Galvanized Steel] [Stainless steel]
 - c. Accessories:
 - 1) Storage bucket for chain hoists with 10-foot (3-m) or greater lift.
 - 2) Chain guides.

5. Hook:

- a. Material: [Forged] [Stainless] steel.
- b. Swivel: Anti-friction type, allowing 360-degree rotation of load.
- c. Furnish spring-loaded safety latch.
- d. Furnish nuts keyed to hook shanks by setscrew.]

D. Electric Hoist

1. Comply with ASME HST-[1] [4]
2. Service Class: H3
3. Motor: Direct-coupled
4. Brakes: Solenoid type.
5. Control Panel:
 - a. Factory mounted.
 - b. Single-point power connection and grounding lug.
6. Controls:
 - a. Pendant Push-Button Station:
 - 1) Comply with NEMA ICS 8.
 - 2) Furnish mounting bracket on hoist to stow pendant when not in use.
 - 3) Push Buttons: RAISE/LOWER, [FORWARD/REVERSE]
 - 4) [Pendant cable reel suspension: Adjustable, self-holding in last position.]
 - b. Controls to permit inching in both directions under full load, automatically regulated acceleration, and rapid brake response.
7. Hoist[/Trolley] Limit Controls:
 - a. Adjustable upper and lower overtravel limit stops
 - b. Adjustable overload limit control
 - c. [Trolley stop limit switch control at each terminus of runway]
8. Sheaves:
 - a. Material: Forged steel.
 - b. Bearings: Permanently lubricated roller type; ABMA 11.
 - c. Minimum Diameter: 20 times rope diameter.
9. Hook:
 - a. Material: [Forged] [Stainless] steel.
 - b. Swivel: Anti-friction type, allowing 360-degree rotation of load.
 - c. Furnish spring-loaded safety latch.
 - d. Furnish nuts keyed to hook shanks by setscrew.

E. Air Hoist

1. Comply with ASME HST-[5] [6]
2. Service Class: A4
3. Air Motor: Direct-coupled
4. Brakes: Mechanical.
5. Controls:
 - a. Pendant Push-Button Station:

- 1) Trolley supported with air hose connection
 - 2) Push Buttons: RAISE/LOWER, [FORWARD/REVERSE]
- b. Controls to permit inching in both directions under full load, automatically regulated acceleration, and rapid brake response.
6. Hoist[/Trolley] Limit Controls:
 - a. Adjustable upper and lower overtravel limit stops
 - b. Adjustable overload limit control
 - c. [Trolley stop limit switch control at each terminus of runway]
7. Sheaves:
 - a. Material: Forged steel.
 - b. Bearings: Permanently lubricated roller type; ABMA 11.
 - c. Minimum Diameter: 20 times rope diameter.
8. Hook:
 - a. Material: [Forged] [Stainless] steel.
 - b. Swivel: Anti-friction type, allowing 360-degree rotation of load.
 - c. Furnish spring-loaded safety latch.
 - d. Furnish nuts keyed to hook shanks by setscrew.
- F. [[Plain] [Geared] Trolley:]
 1. Comply with applicable ASME HST.
 2. Wheels:
 - a. Removable without removing trolley from track.
 - b. Treads: Hardened.
 - c. Electroplated with zinc.
 3. Furnish rubber bumper devices to maintain separation if two or more hoists are located on same monorail track.
 4. [Geared Trolley:
 - a. Gear trains, with operating parts totally enclosed.
 - b. Lubrication: [**Oil bath**] [**Grease**].
 - c. [Trolley Brake: Mechanical type.]
 - d. [Hand Drive Chain: **Welded link [steel]** [**stainless steel**]
- G. [Electric Trolley:
 1. Wheels: Comply with CMAA 74 and MH27.1
 2. Brakes:
 - a. Magnetic-release disc type.
 - b. Integrally mounted to motor.

3. Furnish rubber bumper devices to maintain separation if two or more hoists are located on same monorail track.]

H. [Electrification:

1. Provide junction box to connect power feeder from disconnect switch (by Div. 26).
2. Conductor Bar System
 - a. Single conductor bars enclosed in molded high dielectric plastic cover
 - b. Copper conductors
 - c. Attach to monorail runway
 - d. Trolley mounted adjustable spring-loaded sliding shoe collectors
 - e. Conductor sizing/rating: Comply with CMAA 74 and MH27.1
 - f. No exposed current-carrying surfaces
 - g. Manufacturers: Insul-8-Bar, Safe-T-Bar, Duct-O-Bar or equal.
3. Festoon System:
 - a. Description:
 - 1) Multi-Conductor power supply cables suspended from trolleys mounted on heavy-duty C-track parallel to hoist monorail.
 - 2) Construction: Non-sparking.
 - b. Cables:
 - 1) UL-listed neoprene-jacketed, stranded multi-conductor flat cables.
 - 2) Conductor sizing/rating: Comply with CMAA 74 and MH27.1
 - 3) Length: 110 percent of required length.
 - c. Trolleys:
 - 1) Furnish towing and manufacturer's standard trolleys.
 - 2) Furnish stainless steel tow cable assembly for trolley spacing.
 - 3) Furnish strain-relief cable between first trolley and adjacent wall.
 - d. Festoon Runway:
 - 1) Material: Aluminum or Type 316 stainless steel.
 - 2) End Clamps: Furnish fixed end clamps with outrigger arms.
4. Cable Reel:
 - a. Swivel mounted
 - b. Self-tensioning to limit cable droop
 - c. Construction: Weather-resistant, self-winding, [**explosion-proof,**] and spring operated.
 - d. Roller outlets.
 - e. Conductor sizing/rating: Multi-conductor, UL listed, neoprene jacketed, stranded cable, comply with CMAA 74 and MH27.1]

- f. Manufacturers: Gleason Reel Div. Maysteel Products, Aero-Motive Mfg., Dresser Industries, or equal.]
- I. Mounting Hardware: [Steel] [Galvanized Steel] [[**Type 316**] stainless steel].
- J. [Service Platform
 - 1. Full length of crane girder
 - 2. Fabricated of steel supports with checkered steel plate or grating deck, 42-inch high guard rails, and kick plate.
 - 3. Design to CMAA 70 and OSHA
 - 4. Platform elevation to avoid interference with lifting device and provide overhead clearance not less than 78 inches.
 - 5. Provide fixed platform with access ladder and ladder safety guards for access to service platform.
 - 6. Provide self-closing/latching gates on both platforms.]
- K. Labeling
 - 1. Safety Signs: Comply with NEMA 535.
 - 2. Clearly label capacity of bridge and hoist(s) on each piece of equipment.
- L. Factory Coatings:
 - 1. Apply factory finish paint or coatings to all exposed component surfaces.
 - 2. Apply rust inhibitive coatings to all ferrous surfaces not designated to be painted.
 - 3. Factory surface preparation, priming, and painting to be manufacturer's standard and as specified in Division 9.
 - 4. Finish coat colors to conform to industry standard. Submit color selections as offered.

2.4 SOURCE QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Factory-assemble individual crane components and perform shop inspection and testing of completed assemblies.
- C. Testing:
 - 1. Perform "no-load" running test of controls and drive machinery to ensure proper operation.
 - 2. Proof-test load chains. Comply with applicable ASME HST Standard
 - 3. Comply with OSHA 1919.71
 - 4. Electrical:
 - a. Test hoist, trolley, and bridge controls.
 - b. Verify independent operation of pendant and radio controls.
 - c. Verify operation of limit switches and bypass controls.
- D. [Owner Inspection:

1. Make completed hoist assembly available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least [seven] <_____> days before inspection is allowed.

E. Owner Witnessing:

1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Notify Owner at least [seven] <_____> days before inspections and tests are scheduled.]

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017700 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that systems are ready to receive Work.
- C. Verify that field dimensions are as indicated on [Shop] Drawings.

3.2 INSTALLATION

- A. According to manufacturer instructions and as indicated on Drawings.
- B. Construction: Comply with referenced standards and OSHA 1920.179.
***** [OR] *****
- C. Installation Standards: Install Work according to <_____> standards.

3.3 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
***** [OR] *****
- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Inspection: Check hoist and motor for excessive vibration and noise.
- D. Testing:
 1. Notify Engineer and perform all testing in the presence of Engineer.
 2. Perform initial "no-load" running test of controls and drive machinery to ensure proper operation.
 - a. Operate crane through complete lift and lowering cycle and through complete travel of bridge and trolley under full-load and no-load conditions.

- b. Verify that equipment performs smoothly and safely.
 - c. Verify independent operation of pendant and radio controls.
 - d. Verify that pendant cable length is sufficient to permit operation from desired floor levels.
 - e. Verify that hoist and bridge motions operate as required.
 - f. Verify that limit switches operate as required.
- 3. Perform load tests on bridge, hoist, and trolley through-out full range of access of the bridge crane.
 - a. Load Test Certification: Comply with OSHA Part 1910.179.
 - b. Unit Proof Test: Comply with OSHA Part 1919.71, and ASME B30.16.
 - c. Verify that temperature within enclosures is within tolerance after full-load tests.
- E. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than <_____> [days] [hours] on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- F. Equipment Acceptance:
 - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 - 2. Make final adjustments to equipment under direction of manufacturer's representative.
- G. Repair damaged coatings with material equal to the original coating and as specified in Section 099100 - Painting .

3.4 ADJUSTING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Field-calibrate local controls and indicators.

3.5 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate crane operation, routine maintenance, and emergency repair procedures to Owner's personnel.

3.6 PROTECTION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

- B. Construct temporary protection for equipment and installations, consisting of canvas, heavy plastic, plywood, or other suitable materials, closed tightly and dustproof.

END OF SECTION 412213.13

1. Project Location: 6217 Wilson Blvd & 5104 118th St., Jacksonville, FL.
- B. Owner: JEA
 1. Owner's Representative: Samuel Ramirez
- C. Engineer: CDM Smith Inc.
 1. Engineer's Representative: Jon Goldman
- D. Contractor: CDM Constructors Inc. has been engaged as Contractor for this Project.
 1. Contractor Representative: Ryan Hagaman
- E. Design-Builder: **CDM Constructors Inc.**
 1. Design-Builder Representative: Ryan Hagaman
 2. Design-builder has been engaged for this Project to provide architectural and engineering services and to serve as Project's constructor. The terms "design-builder" and "Contractor" are synonymous.

1.5 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:
 1. Rehabilitate the Wilson Blvd and 118th St. Master Pump Stations including replacing the majority of the mechanical, electrical, and control systems supporting the stations along with other improvements and other Work indicated in the Contract Documents.
- B. Type of Contract:
 1. Project will be constructed under a single prime contract.

1.6 PHASED CONSTRUCTION

- A. Construct the Work phases, with each phase substantially complete as indicated in the Prime Contract.

1.7 WORK PERFORMED BY OWNER

- A. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work under this Contract or work by Owner. Coordinate the Work of this Contract with work performed by Owner.
- B. Preceding Work: Owner will perform the following construction operations at Project site. Those operations are scheduled to be substantially complete before Work under this Contract begins.

1. Owner will mitigate asbestos and lead prior to construction commencement. Owner will also perform programming and security work.

1.8 CONTRACTOR'S USE OF SITE AND PREMISES

- A. Unrestricted Use of Site: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

1.9 WORK RESTRICTIONS

- A. Comply with restrictions on construction operations.
 1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work to between 6 a.m. to 6 p.m., Monday through Friday, unless otherwise indicated. Work hours may be modified to meet Project requirements if approved by Owner and authorities having jurisdiction.
- C.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 011000

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.
- B. Related Requirements:
 - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.2 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
- B. Days – Business days unless otherwise indicated.

1.3 ACTION SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Substitution Request Form: Use facsimile of form provided in Project Manual.
 - 2. Documentation: Cited examples are used only to denote the quality standard of product desired and that they do not restrict the bidders to a specific brand, make, manufacturer or specific name; that they are used only to set forth and convey to bidders the general style, type, character and quality of product desired; and that equivalent products will be acceptable. Show compliance with requirements for substitutions and the following, as applicable:
 - a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.
 - b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.

- c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Certificates and qualification data, where applicable or requested.
 - g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Engineers and owners.
 - h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
 - i. Research reports evidencing compliance with building code in effect for Project.
 - j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - k. Cost information, including a proposal of change, if any, in the Contract Sum.
 - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
 - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or five days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Addenda, Change Order, Construction Change Directive, or Engineer's Supplemental Instructions for minor changes in the Work.
 - b. Use product specified if Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.4 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.5 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.6 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: Engineer will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of Engineer.
 - 1. Conditions: Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 - b. Requested substitution does not require extensive revisions to the Contract Documents.
 - c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - d. Substitution request is fully documented and properly submitted.
 - e. Requested substitution will not adversely affect Contractor's construction schedule.

- f. Requested substitution has received necessary approvals of authorities having jurisdiction.
- g. Requested substitution is compatible with other portions of the Work.
- h. Requested substitution has been coordinated with other portions of the Work.
- i. Requested substitution provides specified warranty.
- j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012500

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. RFIs.
 - 4. Digital project management procedures.
 - 5. Project meetings.
- B. Related Requirements:
 - 1. Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
 - 2. Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
 - 3. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.

1.2 DEFINITIONS

- A. RFI: Request for Information. Request from Owner, Engineer, or Contractor seeking information required by or clarifications of the Contract Documents.

1.3 INFORMATIONAL SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses.

1.4 GENERAL COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
 - 4. Do not interfere with ongoing plant operations.
- C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Preinstallation conferences.
 - 7. Project closeout activities.
 - 8. Startup and adjustment of systems.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate subframing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:
 - a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
 - b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
 - c. Fire-rated enclosures around ductwork.
7. Electrical Work: Show the following:

- a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
 - b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
 - c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
 - d. Location of pull boxes and junction boxes, dimensioned from column center lines.
 8. Fire-Protection System: Show the following:
 - a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
 9. Review: Engineer will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Engineer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Engineer will so inform Contractor, who shall make suitable modifications and resubmit.
 10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
1. File Preparation Format: **[DWG]** **[DXF]**, operating in Microsoft Windows operating system.
 2. File Submittal Format: Submit or post coordination drawing files using PDF format.
 3. Engineer may furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Contractor shall execute a data licensing agreement in the form of AIA Document C106 or Agreement form acceptable to Owner and Engineer.

1.6 REQUEST FOR INFORMATION (RFI)

- A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
 2. Project number.
 3. Date.
 4. Name of Contractor.

5. Name of Engineer.
 6. RFI number, numbered sequentially.
 7. RFI subject.
 8. Specification Section number and title and related paragraphs, as appropriate.
 9. Drawing number and detail references, as appropriate.
 10. Field dimensions and conditions, as appropriate.
 11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
 12. Contractor's signature.
 13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
 - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. RFI Forms: Software-generated form with substantially the same content as indicated above, or form acceptable to Engineer.
1. Attachments shall be electronic files in PDF format.
- D. Engineer's Action: Engineer will review each RFI, determine action required, and respond. Allow seven days for Engineer's response for each RFI.
1. The following Contractor-generated RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for approval of Contractor's means and methods.
 - d. Requests for coordination information already indicated in the Contract Documents.
 - e. Requests for adjustments in the Contract Time or the Contract Sum.
 - f. Requests for interpretation of Engineer's actions on submittals.
 - g. Incomplete RFIs or inaccurately prepared RFIs.
 2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt by Engineer of additional information.
 3. Engineer's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal.
 - a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Engineer in writing in accordance with the terms of the Subcontract Agreement.
- E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log bi-weekly. Software log with not less than the following:
1. Project name.
 2. Name and address of Contractor.
 3. RFI number including RFIs that were returned without action or withdrawn.

4. RFI description.
 5. Date the RFI was submitted.
 6. Date Engineer's response was received.
 7. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.
- F. On receipt of Engineer's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Engineer within 5 days if Contractor disagrees with response.

1.7 DIGITAL PROJECT MANAGEMENT PROCEDURES

- A. Use of Engineer's Digital Data Files: Digital data files of Engineer's CAD drawings may be provided by Engineer for Contractor's use during construction.
1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project record Drawings.
 2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
 3. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement or Agreement form acceptable to Owner and Engineer.
 - a. Subcontractors, and other parties granted access by Contractor to Engineer's digital data files shall execute a data licensing agreement in the form of AIA Document C106 or Agreement acceptable to Owner and Engineer.
- B. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare as follows:
1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 2. Name file with submittal number or other unique identifier, including revision identifier.
 3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013100

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

B. Related Requirements:

1. Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
2. Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and final completion construction photographs.
4. Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
5. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
6. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
7. Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
8. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. Days – Business Days unless otherwise indicated.
- D. Mass Submittals: **20** or more submittals or items in one week.

1.3 SUBMITTAL SCHEDULE

- A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and additional time for handling and reviewing submittals required by those corrections.
1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 2 months of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.
 - a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.
 4. Format: Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal.
 - b. Specification Section number and title.
 - c. Submittal Category: Action; informational.
 - d. Name of subcontractor.
 - e. Description of the Work covered.
 - f. Scheduled date for Engineer's final release or approval.
 - g. Scheduled dates for purchasing.
 - h. Scheduled date of fabrication.
 - i. Scheduled dates for installation.
 - j. Activity or event number.

1.4 SUBMITTAL FORMATS

- A. Numbering System: Utilize the following example submittal identification numbering system to identify submittals and as file names for PDF submissions:
1. First Identifier - Alphabet Character: D, S, M or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.
 2. Second Identifier - Next 6 or 8 Digits: Applicable Specification Section Number. Do not mix submittals from different specification sections into a single submittal.
 3. Third Identifier - Next Three Digits: Sequential number of each separate item or drawing submitted under each Specification Section, in chronological order submitted, starting at 001.
 4. Fourth Identifier - Last Alphabet Character: A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc.
 5. EXAMPLE: D-033000.13-008-B.

- a. D = Shop Drawing.
- b. 03 30 00.13 = Section; use only 6 digits for sections that do not include 8 digits.
- c. 008 = the eighth different submittal under this Section.
- d. B = the second submission (first resubmission) of that particular shop drawing.

B. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Engineer.
4. Name of Contractor.
5. Name of firm or entity that prepared submittal.
6. Names of subcontractor, manufacturer, and supplier.
7. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.
8. Category and type of submittal.
9. Submittal purpose and description.
10. Number of Specification Section, with paragraph number and generic name for each of multiple items.
11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.

C. Options: Identify options requiring selection by Engineer.

D. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

E. Paper Submittals: Where needed.

1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.

F. Submittals for Web-Based Project Software: Prepare submittals as PDF files, incorporating complete information into each PDF file. Name PDF file with submittal number or other format indicated by Project software website.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 2. Paper: Prepare submittals in paper form and deliver to Engineer.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
1. Initial Review: Allow **15** days for initial review of each submittal (and 30 days for multi-discipline reviews). Allow additional time if coordination with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow **15** days for review of each resubmittal.
 4. Sequential Review: Where sequential review of submittals by Engineer's consultants, Owner, or other parties is indicated, allow **20** days for initial review of each submittal.
 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Engineer and to Engineer's consultants, allow **20** days for review of each submittal. Submittal will be returned to before being returned to Contractor.
- D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Engineer's action stamp.
 4. Repetitive Reviews: Shop drawings, O&M manuals, and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will be performed at the Contractor's expense. Reimburse the Design Builder for all costs invoiced by Engineer for the third and subsequent reviews.

- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms or project software.
- F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer's action stamp.

1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 - 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
 - 2. Mark each copy of each submittal to show which products and options are applicable.
 - 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 - 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams that show factory-installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 - 5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Engineer's digital data drawing files is otherwise permitted.
 - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings in pdf files set to print at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
 - a. Project name and submittal number.
 - b. Generic description of Sample.
 - c. Product name and name of manufacturer.
 - d. Sample source.
 - e. Number and title of applicable Specification Section.
 - f. Specification paragraph number and generic name of each item.
 3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
 4. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
 5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
 6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
 7. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
 8. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

- a. Number of Samples: Submit two sets of Samples unless otherwise requested by Owner. Engineer will retain one Sample sets; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number if applicable.
 3. Number and name of room or space.
 4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
 1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
 2. Contractor's Certification: Each shop drawing, working drawing, product data, and sample shall have affixed to it the following Certification Statement:
 - a. "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements. "
 3. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
 4. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

5. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
6. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
7. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on American Welding Society (AWS) forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - a. Name of evaluation organization.
 - b. Date of evaluation.
 - c. Time period when report is in effect.
 - d. Product and manufacturers' names.
 - e. Description of product.
 - f. Test procedures and results.
 - g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Engineer.

- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file and two paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional registered in the State of Florida.

1.8 PROPOSED PRODUCT LIST

- A. Within **20** days after date of Notice to Proceed, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
- B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.9 CONTRACTOR'S REVIEW

- A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Contractor Responsible for:
 - 1. Determination and verification of materials including manufacturer's catalog numbers.
 - 2. Determination and verification of field measurements and field construction criteria.
 - 3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
 - 4. Determination of accuracy and completeness of dimensions and quantities.
 - 5. Confirmation and coordination of dimensions and field conditions at Site.
 - 6. Construction means, techniques, sequences, and procedures.
 - 7. Safety precautions.
 - 8. Coordination and performance of Work of all trades.
 - 9. Other requirements enumerated in Contract Documents.
- C. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp indicated in web-based Project software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.
 - 1. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.

1.10 ENGINEER'S REVIEW

- A. Do not make mass submittals to Engineer. If mass submittals are received, Engineer's review time stated above will be extended as necessary to perform proper review. Engineer will review mass submittals based on priority determined by Engineer after consultation with Owner and Design Builder.

- B. Action Submittals: Engineer will review each submittal, indicate corrections or revisions required, and return it.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.
- E. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- F. Engineer will return without review submittals received from sources other than Contractor.
- G. Shop drawings will be returned to the Contractor with one of the following codes.
 - 1. "APPROVED" - This code is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.
 - 2. "APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.
 - 3. "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. The resubmittal is to address all comments, omissions and non-conforming items that were noted. An additional box is checked to indicate whether the resubmission is for the complete package, or for parts of the package. If no box is checked, a complete resubmittal shall be provided. Review code may designate if a partial or full submittal is required. If full submittal is required, a complete resubmittal package addressing all comments shall be provided. If a partial submittal is designated, resubmittal shall only include information pertaining to those items noted in review comments requiring clarification and any portions of submittal impacted as a result of the response. Resubmittal is to be received by the Engineer within 30 calendar days of the date of the Engineer's transmittal requiring the resubmittal.
 - 4. "REJECTED" - This code is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the Contract Documents.
 - 5. "RECEIPT ACKNOWLEDGED (Not subject to Engineer's Approval)" - This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's approval. This code is generally used with submittals involving the Contractor's means and methods of construction work plans, and health and safety plans.

1.11 ELECTRONIC CAD FILES OF PROJECT DRAWINGS

- A. Electronic CAD Files of Project Drawings: May only be used to expedite production of Shop Drawings for the Project. Use for other Projects or purposes is not allowed.
- B. Electronic CAD Files of Project Drawings: Distributed only under the following conditions:
 - 1. Use of files is solely at receiver's risk. Engineer does not warrant accuracy of files. Receiving files in electronic form does not relieve receiver of responsibilities for measurements, dimensions, and quantities set forth in Contract Documents. In the event of ambiguity, discrepancy, or conflict between information on electronic media and that in Contract Documents, notify Engineer of discrepancy and use information in hard-copy Drawings and Specifications.
 - 2. CAD files do not necessarily represent the latest Contract Documents, existing conditions, and as-built conditions. Receiver is responsible for determining and complying with these conditions and for incorporating addenda and modifications.
 - 3. User is responsible for removing information not normally provided on Shop Drawings and removing references to Contract Documents. Shop Drawings submitted with information associated with other trades or with references to Contract Documents will not be reviewed and will be immediately returned.
 - 4. Receiver shall not hold Engineer responsible for data or file clean-up required to make files usable, nor for error or malfunction in translation, interpretation, or use of this electronic information.
 - 5. Receiver shall understand that even though Engineer has computer virus scanning software to detect presence of computer viruses, there is no guarantee that computer viruses are not present in files or in electronic media.
 - 6. Receiver shall not hold Engineer responsible for such viruses or their consequences, and shall hold Engineer/Engineer harmless against costs, losses, or damage caused by presence of computer virus in files or media.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.
 - 4. Specific test and inspection requirements are not specified in this Section.
- C. Related Requirements:
 - 1. Section 017300 "Execution" for testing and inspection allowances.

1.2 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of three previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- H. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- I. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Engineer.

1.3 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Engineer.

1.4 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for direction before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

1.5 DELEGATED DESIGN

- A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.
 - 1. Delegated-Designer: Professionals currently registered in State in which project work occurs.

1.6 INFORMATIONAL SUBMITTALS

- A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.
- B. Qualification Data: For Contractor's quality-control personnel and Delegated-Designer.
- C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- F. Reports: Prepare and submit certified written reports and documents as specified.
- G. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

- A. Quality-Control Plan, General: Submit quality-control plan within **10** days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's Construction Schedule.
- B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
- C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.
- D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:
 - 1. Contractor-performed tests and inspections including Subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
 - 2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
 - 3. Owner-performed tests and inspections indicated in the Contract Documents.
- E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.
- F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.

8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at Project site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, telephone number, and email address of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

1.9 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

- D. **Installer Qualifications:** A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.
- F. **Specialists:** Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. **Testing Agency Qualifications:** An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to **ASTM E 329**; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. **Manufacturer's Technical Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. **Factory-Authorized Service Representative Qualifications:** An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. **Preconstruction Testing:** Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - 2. **Testing Agency Responsibilities:** Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.10 QUALITY CONTROL

- A. Contractor Responsibilities: Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Engage a qualified testing agency to perform quality-control services. Notify testing agencies at least **24** hours in advance of time when Work that requires testing or inspection will be performed or as required by testing agency if greater.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- B. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- C. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform duties of Contractor.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."
- E. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- F. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary

services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.
 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspection equipment at Project site.
- G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection. Schedule times for tests, inspections, obtaining samples, and similar activities.
- H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Conducted by a qualified testing agency or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, or on the Drawings and as follows:
1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected work..

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Engineer.
 - 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.
 - 1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.3 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
4. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
5. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
6. ABMA - American Boiler Manufacturers Association; www.abma.com.
7. ACI - American Concrete Institute; (Formerly: ACI International); www.concrete.org
8. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
9. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
10. AF&PA - American Forest & Paper Association; www.afandpa.org.
11. AGA - American Gas Association; www.aga.org.
12. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
13. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
14. AI - Asphalt Institute; www.asphaltinstitute.org.
15. AIA - American Institute of Architects (The); www.aia.org.
16. AISC - American Institute of Steel Construction; www.aisc.org.
17. AISI - American Iron and Steel Institute; www.steel.org.
18. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
19. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
20. ANSI - American National Standards Institute; www.ansi.org.
21. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
22. APA - APA - The Engineered Wood Association; www.apawood.org.
23. APA - Architectural Precast Association; www.archprecast.org.
24. API - American Petroleum Institute; www.api.org.
25. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
26. ARI - American Refrigeration Institute; (See AHRI).
27. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
28. ASCE - American Society of Civil Engineers; www.asce.org.
29. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
30. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
31. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
32. ASSE - American Society of Safety Engineers (The); www.asse.org.
33. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
34. ASTM - ASTM International; www.astm.org.
35. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
36. AWEA - American Wind Energy Association; www.awea.org.

37. AWI - Architectural Woodwork Institute; www.awinet.org.
38. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
39. AWWA - American Wood Protection Association; www.awpa.com.
40. AWS - American Welding Society; www.aws.org.
41. AWWA - American Water Works Association; www.awwa.org.
42. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
43. BIA - Brick Industry Association (The); www.gobrick.com.
44. BICSI - BICSI, Inc.; www.bicsi.org.
45. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
46. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
47. CDA - Copper Development Association; www.copper.org.
48. CEA - Consumer Electronics Association; www.ce.org.
49. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
50. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
51. CGA - Compressed Gas Association; www.cganet.com.
52. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
53. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
54. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
55. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
56. CPA - Composite Panel Association; www.pbmdf.com.
57. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
58. CRRC - Cool Roof Rating Council; www.coolroofs.org.
59. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
60. CSI - Construction Specifications Institute (The); www.csinet.org.
61. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
62. CWC - Composite Wood Council; (See CPA).
63. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
64. DHI - Door and Hardware Institute; www.dhi.org.
65. ECA - Electronic Components Association; (See ECIA).
66. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
67. ECIA - Electronic Components Industry Association; www.eciaonline.org.
68. EIA - Electronic Industries Alliance; (See TIA).
69. EIMA - EIFS Industry Members Association; www.eima.com.
70. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
71. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
72. ETL - Intertek (See Intertek); www.intertek.com.
73. EVO - Efficiency Valuation Organization; www.evo-world.org.
74. FCI - Fluid Controls Institute; www.fluidcontrolsintstitute.org.
75. FM Approvals - FM Approvals LLC; www.fmglobal.com.
76. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.
77. FSA - Fluid Sealing Association; www.fluidsealing.com.
78. FSC - Forest Stewardship Council U.S.; www.fscus.org.
79. GA - Gypsum Association; www.gypsum.org.
80. GANA - Glass Association of North America; www.glasswebsite.com.
81. GS - Green Seal; www.greenseal.org.
82. HI - Hydraulic Institute; www.pumps.org.
83. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
84. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
85. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.

86. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
87. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
88. IAS - International Accreditation Service; www.iasonline.org.
89. IAS - International Approval Services; (See CSA).
90. ICBO - International Conference of Building Officials; (See ICC).
91. ICC - International Code Council; www.iccsafe.org.
92. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
93. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
94. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
95. IEC - International Electrotechnical Commission; www.iec.ch.
96. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
97. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
98. IESNA - Illuminating Engineering Society of North America; (See IES).
99. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
100. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
101. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
102. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
103. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
104. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
105. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
106. ISO - International Organization for Standardization; www.iso.org.
107. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
108. ITU - International Telecommunication Union; www.itu.int/home.
109. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
110. LMA - Laminating Materials Association; (See CPA).
111. LPI - Lightning Protection Institute; www.lightning.org.
112. MBMA - Metal Building Manufacturers Association; www.mbma.com.
113. MCA - Metal Construction Association; www.metalconstruction.org.
114. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
115. MHIA - Material Handling Industry of America; www.mhia.org.
116. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
117. MPI - Master Painters Institute; www.paintinfo.com.
118. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
119. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
120. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
121. NADCA - National Air Duct Cleaners Association; www.nadca.com.
122. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
123. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
124. NBI - New Buildings Institute; www.newbuildings.org.
125. NCMA - National Concrete Masonry Association; www.ncma.org.
126. NEBB - National Environmental Balancing Bureau; www.nebb.org.
127. NECA - National Electrical Contractors Association; www.necanet.org.
128. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.

129. NEMA - National Electrical Manufacturers Association; www.nema.org.
130. NETA - InterNational Electrical Testing Association; www.netaworld.org.
131. NFPA - National Fire Protection Association; www.nfpa.org.
132. NFPA - NFPA International; (See NFPA).
133. NFRC - National Fenestration Rating Council; www.nfrc.org.
134. NHLA - National Hardwood Lumber Association; www.nhla.com.
135. NLGA - National Lumber Grades Authority; www.nlga.org.
136. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
137. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
138. NRCA - National Roofing Contractors Association; www.nrca.net.
139. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
140. NSF - NSF International; www.nsf.org.
141. NSPE - National Society of Professional Engineers; www.nspe.org.
142. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
143. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
144. NWFA - National Wood Flooring Association; www.nwfa.org.
145. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
146. PDI - Plumbing & Drainage Institute; www.pdionline.org.
147. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
148. RFCI - Resilient Floor Covering Institute; www.rfci.com.
149. SAE - SAE International; www.sae.org.
150. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
151. SDI - Steel Deck Institute; www.sdi.org.
152. SDI - Steel Door Institute; www.steeldoor.org.
153. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
154. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
155. SIA - Security Industry Association; www.siaonline.org.
156. SJI - Steel Joist Institute; www.steeljoist.org.
157. SMA - Screen Manufacturers Association; www.smainfo.org.
158. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
159. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
160. SPIB - Southern Pine Inspection Bureau; www.spib.org.
161. SPRI - Single Ply Roofing Industry; www.spri.org.
162. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
163. SSINA - Specialty Steel Industry of North America; www.ssina.com.
164. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
165. STI - Steel Tank Institute; www.steeltank.com.
166. SWI - Steel Window Institute; www.steelwindows.com.
167. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
168. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
169. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
170. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
171. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
172. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
173. TMS - The Masonry Society; www.masonrysociety.org.
174. TPI - Truss Plate Institute; www.tpinst.org.

175. TPI - Turfgrass Producers International; www.turfgrasssod.org.
176. TRI - Tile Roofing Institute; www.tilerroofing.org.
177. UL - Underwriters Laboratories Inc.; <http://www.ul.com>.
178. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
179. WA - Wallcoverings Association; www.wallcoverings.org
180. WASTEC - Waste Equipment Technology Association; www.wastec.org.
181. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
182. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
183. WDMA - Window & Door Manufacturers Association; www.wdma.com.
184. WI - Woodwork Institute; www.wicnet.org.
185. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
186. WWPA - Western Wood Products Association; www.wwpa.org.

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
2. ICC - International Code Council; www.iccsafe.org.
3. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FG - Federal Government Publications; www.gpo.gov/fdsys.
8. GSA - General Services Administration; www.gsa.gov.
9. HUD - Department of Housing and Urban Development; www.hud.gov.
10. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
11. OSHA - Occupational Safety & Health Administration; www.osha.gov.
12. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
13. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
14. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
15. USDOJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
16. USP - U.S. Pharmacopeial Convention; www.usp.org.

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and

regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. DSCC - Defense Supply Center Columbus; (See FS).
3. FED-STD - Federal Standard; (See FS).
4. USAB - United States Access Board; www.access-board.gov.
5. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 014200

SECTION 014500 - SUBCONTRACTORS QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Requirements for Subcontractor Quality Control Organization
2. Subcontractor's Site-Specific Quality Control Plan
3. Subcontractor's Quality Control Reporting
4. For the purposes of this Section, Contractor refers to CCI and Subcontractor refers to the entities subcontracted to CCI.

B. Related Requirements:

1. Section 013100 "Project Management and Coordination" Coordination and Meetings
2. Section 013300 "Submittal Procedures"
3. Section 014000 "Quality Procedures"
4. Section 014520 "Inspection Services"
5. Section 014540 "Testing Laboratory Services"
6. Section 014580 "Special Inspection Services"
7. Section 016000 "Product Requirements"

1.2 DEFINITIONS

- A. Subcontractor Quality Control (SQC): The means by which subcontractor ensures and assures the Contractor that the construction work, including that work performed by lower tier subcontractors and suppliers, complies with the requirements of the Contract Documents.
- B. "Subcontractor" shall include the organization contracted to the Contractor, in addition to lower tier subcontractors, suppliers, vendors, and fabricators contracted to the subcontractor.

1.3 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the Site-Specific SQC Plan, schedule a meeting with Contractor and Owner to discuss the quality control system.
- B. Develop a mutual understanding of the system details, including the forms for recording the SQC operations, control activities, testing and administration of the system for both onsite and offsite Work, and the interrelationship of subcontractor's management and control with the Contractor's Inspection Services. Contractor will create and distribute forms for the recording of SQC inspection and testing operations.

- C. The Subcontractor will be required to attend a Preparatory meeting with the Contractor and the Owner prior to start of each feature of work to be executed under the subcontract. The features of work will be selected by the Contractor.
- D. There may be occasions when subsequent conferences may be called by Contractor or Subcontractor to reconfirm mutual understandings and/or address deficiencies in the SQC system or adjust procedures that may require corrective action by subcontractor.

1.4 INFORMATIONAL SUBMITTALS

- A. Site-Specific SQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
- B. SQC Daily Report: Submit daily report form via website.
- C. SQC Monthly Report: Submit monthly report form via website.

1.5 CONTRACTOR'S INSPECTION SERVICES

- A. All work is subject to Contractor's Inspection Services as included in Section 014520 and Testing Laboratory Services included in Section 014540.
- B. Contractor's inspections and tests are for the sole benefit of Contractor and do not:
 - 1. Relieve subcontractor of responsibility for providing adequate quality control measures;
 - 2. Relieve subcontractor of responsibility for damage to or loss of the material before acceptance;
 - 3. Constitute or imply acceptance; or
 - 4. Affect the continuing rights of Contractor after acceptance of the completed Work.
- C. The presence or absence of an Inspector does not relieve subcontractor from any Contract requirement.
- D. Promptly furnish all facilities, labor, material and equipment reasonably needed to perform safe and convenient inspections and tests as may be required by Contractor.
- E. Contractor may charge subcontractor for any additional cost of inspections or tests when work is not ready at the time specified by subcontractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Provided that subcontractor has provided adequate notice, inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL

- A. Subcontractor will maintain an adequate internal inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents and conforms to the construction schedule.
- B. Maintain complete inspection records and make them available at all times to Contractor and Owner. Records shall include a Daily Report, Daily Inspection Log and Daily Quality Control tasks complete with date stamped photos.
- C. The quality control systems shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, and suppliers, and shall be aligned with the proposed construction sequence.

3.2 QUALITY CONTROL ORGANIZATION

- A. SQC Manager:
 - 1. For subcontracts worth \$10 million or greater, subcontractor shall include a dedicated SQC Manager for coordination with Contractor's inspection and testing staff.
 - 2. Designate an individual within subcontractor's own organization who will be responsible for overall management of SQC and have the authority to act in SQC matters for the subcontractor. SQC Manager will not perform other duties on the Project without the approval of the Contractor, but such approval will not be unreasonably withheld.
 - 3. SQC Manager shall be an experienced construction person, familiar with three phase project control, and have a minimum of 5 years construction experience on similar types of Work.
 - 4. SQC Manager shall report to the subcontractor's Project Manager or someone higher in the organization. Project Manager in this context shall mean the individual with responsibility for the overall contract management of the Project.
 - 5. SQC Manager shall be onsite during construction at all times.
 - 6. Identify an alternate for the SQC Manager to serve with full authority during the Quality Manager's absence. The requirements for experience for the alternate will be the same as for designated SQC Manager.
- B. SQC Staff:
 - 1. Designate SQC staff necessary to support the Work, available at the Site at all times during work progress, with authority to take any actions necessary to ensure compliance with the Contract Documents. SQC staff members shall be subject to acceptance by Contractor. Subcontractor shall submit resumes of proposed quality staff to the Contractor for approval.
 - 2. SQC staff shall take direction from the SQC Manager in matters pertaining to Quality Control.
 - 3. SQC staff must be of sufficient size to ensure adequate QC coverage of work phases, work shifts, and work crews involved in the construction. Subcontractor shall add additional staff commensurate with the magnitude of Work at any given time. Contractor may require additional SQC staff be added at Subcontractor's cost if Contractor determines Subcontractor has insufficient SQC resources allocated to the Work.

4. Organizational Changes: Obtain Contractor's acceptance before replacing any member of the SQC staff. Requests for change shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.3 INSPECTION AND TESTING PLAN (ITP)

- A. SQC Manager shall include the subcontractor's Inspection and Testing Plans as part of the Quality Control Plan to be conducted in conjunction with the features of the Work. ITP's for the subcontractor's quality control program shall include a minimum of the following requirements:
- B. Subcontractor shall prepare ITP Plans prior to the preparatory meeting for review by Contractor. The SQC Manager shall instruct applicable SQC staff as to the acceptable level of workmanship required in order to meet Contract requirements for ITPs, which shall include:
 1. Subcontractor methods to perform the Work
 2. Subcontractor method to inspect the work performed in accordance with ITP
 3. Review of applicable Contract Specifications.
 4. Review of applicable Contract Drawings.
 5. Verify that all materials and/or equipment have been tested, submitted, and approved.
 6. Verify that provisions have been made to provide required control inspection and testing.
 7. Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract Documents.
 8. Perform a physical examination, in conjunction with the Contractor's appointed inspector, of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
 9. Review the appropriate activity submittals and Task Hazard Analysis (THA) to verify safety requirements are met.
 10. Document construction tolerances and workmanship standards for that phase of the Work.
 11. Check to verify that the plan for the Work to be performed, if so required, has been accepted by Contractor.

3.4 SUBCONTRACTOR SITE-SPECIFIC QUALITY CONTROL PLAN

- A. General:
 1. Plan shall identify personnel, procedures, control, and instructions. Test records, and forms to be used will be provided by the Contractor. Other forms may be proposed by the subcontractor.
 2. Plan will include all subcontractor Inspection and Testing Plans to perform the work
 3. An Interim Plan for the first 30 days of construction operation will be considered.
 4. Construction will be permitted to begin only after acceptance of the Site-Specific SQC Plan or after acceptance of an Interim Plan applicable to the particular feature of Work to be started.
 5. Work outside of the features of Work included in an accepted Interim plan will not be permitted to begin until acceptance of a SQC Plan or another Interim Plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended SQC organization for the entire Subcontract and shall include the following, as a minimum:
 - a. Clear definition of interaction and coordination with the Contractor.
 - b. Organization: Description of the subcontractor's quality control organization, including a chart showing lines of authority and acknowledgment that the SQC staff will implement the three-phase control system for all aspects of the Work specified.
 - c. SQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
 - d. Letters of Authority: A copy of a letter to the SQC Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the SQC Manager, including authority to stop Work which is not in compliance with the Contract Documents.
 - e. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of offsite fabricators, suppliers and lower tier subcontractors.
 - f. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the Contractor personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
 - g. Reporting procedures, including proposed reporting formats; include a copy of the SQC report form.

C. Acceptance of Plans: An SQC plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Contractor reserves the right to require subcontractor to make changes in the SQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

D. Notification of changes: After acceptance of the SQC plan, subcontractor shall notify Contractor, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Contractor.

3.5 SUBCONTRACTOR QUALITY CONTROL REPORT

- A. As a minimum, prepare a SQC Report for every 7 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by SQC Manager. Include copies of test reports and copies of reports prepared by QC staff.
- B. Maintain current records of quality control operations, activities, and tests performed, including the Work of lower tier subcontractors and suppliers.
- C. Records shall be on an acceptable form. They shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
 1. Lower tier subcontractors and their areas of responsibility
 2. Operating equipment with hours worked, idle, or down for repair.

3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
5. Material received with statement as to its acceptability, storage, and protective measures.
6. Identify submittals reviewed, with Subcontract reference, by whom, status, and action taken.
7. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
8. List instructions given/received and conflicts, if any, in the Contract Documents.
9. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
10. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract Documents.

3.6 SUBMITTAL QUALITY CONTROL

- A. Submittals shall be as specified in Section 013300, Submittal Procedures. The SQC Manager shall be responsible for certifying that all submittals are in compliance with the Contract Documents. Contractor will furnish copies of test report forms upon request by subcontractor. Subcontractor may use other forms as approved by Contractor.

3.7 TESTING QUALITY CONTROL

- A. Testing Procedure:
 1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract Documents. Coordinate Inspection Services described in Section 014520, and Testing Laboratory Services as required in Section 014540 of the specifications.

END OF SECTION 014500

SECTION 014540 – TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Testing laboratory services and Subcontractor responsibilities related to those services.
2. For the purposes of this Section, Contractor refers to CCI and Subcontractor refers to the entities subcontracted to CCI.

B. Related Requirements:

1. Section 013100 “Project Management and Coordination” Coordination and Meetings
2. Section 013300 “Submittal Procedures”
3. Section 014000 “Quality Procedures”
4. Section 014500 “Subcontractors Quality Control”
5. Section 014520 “Inspection Services”
6. Section 014580 “Special Inspection Services”
7. Section 016000 “Product Requirements”

1.2 REFERENCES

- A. ASTM C 1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
- B. ASTM D 3666 - Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials.
- C. ASTM D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- D. ASTM E 329 - Standard Specification for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- E. ISO/TEC Guide 25 - General Requirements for the Competence of Calibration and Testing Laboratories.

1.3 SELECTION AND PAYMENT

- A. The Contractor will select, employ, and pay for services of an independent testing laboratory to perform inspection and testing identified in Part 3 of individual Specification sections.
- B. Subcontractor shall employ and pay for services of an independent testing laboratory or laboratories to perform inspection and testing identified in Part 2 of individual Specification

sections (i.e. High potential testing, partial discharge monitoring, HVAC testing and balancing, etc.).

- C. Employment of a testing laboratory by the Contractor shall not relieve subcontractor of its obligation to perform work in accordance with requirements of Contract Documents.
- D. The Contractor will deduct a minimum two-hour charge for testing laboratory time from periodic progress payment when operations requiring testing or inspection are canceled without prior notification.
- E. The Contractor will deduct cost of retesting from periodic progress payment whenever failed work is removed, replaced, and retested.
- F. Testing laboratory will have full-time, on site representation and an on-site laboratory.

1.4 QUALIFICATION OF LABORATORY

- A. Meet laboratory requirements of ASTM E 329 and applicable requirements of ASTM C 1077, ASTM D 3666, and ASTM D 3740.
- B. Meet ISO/TEC Guide 17025 conditions for accreditation by the American Association for Laboratory Accreditation (A2LA) in specific fields of testing required in individual Specification sections.
- C. If laboratory subcontracts are part of the testing services, such work will be placed with a laboratory complying with the requirements of this Section.

1.5 LABORATORY REPORTS

- A. Testing laboratory shall provide and distribute copies of laboratory reports simultaneously to the subcontractor and the Contractor.
- B. Testing laboratory shall upload laboratory reports to Aconex. Testing laboratory shall ensure that file naming conventions and upload locations meet the requirements of the Contractor.
- C. Subcontractor shall keep one copy of each laboratory report distributed or faxed at the site field office for duration of the Work.
- D. Laboratory will email material supplier, subcontractor, lower tier subcontractors, and Contractor reports that indicate failing test results by no later than close of business on the working day following test completion and review.

1.6 LIMITS ON TESTING LABORATORY AUTHORITY

- A. Laboratory may not release, revoke, alter, or enlarge requirements of the Contract.
- B. Laboratory may not approve or accept any portion of the Work.
- C. Laboratory may not assume subcontractor duties.

- D. Laboratory has no authority to stop the Work.

1.7 SUBCONTRACTOR RESPONSIBILITIES

- A. Provide safe access to the Work and to manufacturer's facilities for Contractor and for testing laboratory personnel.
- B. Provide testing laboratory with three-week look ahead schedules, copy of the Construction Schedule and a copy of each update to Construction Schedule.
- C. Notify Contractor and testing laboratory during normal working hours of the day previous to expected time for operations requiring inspection and testing services. When subcontractor fails to make timely prior notification, do not proceed with the operations requiring inspection and testing services.
- D. Notify Contractor 48 hours in advance when Contract Documents require presence of Special Inspector, as outlined in Section 014520, for sampling or testing.
- E. Notify Contractor and Testing Laboratory 48 hours in advance of after hour, weekend, or holiday Work.
- F. Request and monitor testing as required to provide timely results and to avoid delays to the Work. Provide samples to laboratory in sufficient time to allow required test to be performed in accordance with specified test methods before intended use of the Product.
- G. Cooperate with laboratory personnel in collecting samples on site. Provide incidental labor and facilities for safe access to the Work to be tested, to obtain and handle samples at site or at source of Products to be tested, and to facilitate tests and inspections including storage and curing of test samples.
- H. Subcontractor shall make all arrangements with Testing Laboratory. Payment for additional testing will be made in accordance with Testing Laboratory Rate Sheets and shall include:
 - 1. Re-testing required for failed tests.
 - 2. Re-testing for nonconforming work.
 - 3. Additional sampling and tests requested beyond specified requirements.
 - 4. Insufficient notification of cancellation of tests for work scheduled but not performed.
 - 5. Testing Laboratory may have full time representation at the project site including the use of an on-site laboratory. Testing Laboratory will make every effort to meet subcontractor requests for service.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 CONDUCTING TESTING

- A. Conform to laboratory sampling and testing methods specified in individual Specification sections to the latest issues of ASTM standards, or other recognized test standards as approved by Contractor.
- B. Requirements of this Section shall also apply to those tests for approval of materials, for mix designs, and for quality control of materials as performed by employed testing laboratories.

END OF SECTION 014500

SECTION 014580 – SPECIAL INSPECTION SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Special Inspection, Observations, and Testing required in accordance with Chapter 17 of the 2012 International Building Code and is in addition to and supplements requirements included in Statement of Special Inspection (Plan) shown in the Contract Documents.
2. For the purposes of this Section, Contractor refers to CCI and Subcontractor refers to the entities subcontracted to CCI.

B. Related Requirements:

1. Section 013100 “Project Management and Coordination” Coordination and Meetings
2. Section 013300 “Submittal Procedures”
3. Section 014000 “Quality Procedures”
4. Section 014500 “Subcontractors Quality Control”
5. Section 014520 “Inspection Services”
6. Section 014540 “Testing Laboratory Services”
7. Section 016000 “Product Requirements”

1.2 DEFINITIONS

A. Agencies and Personnel:

1. Approved Testing Agency: An established, recognized, and independent agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
2. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the Project is to be constructed.
3. Special Inspector: Qualified person employed or retained by Approved Testing Agency who will demonstrate competence to the satisfaction of the building official for inspection of a particular type of construction or operation requiring Special Inspection.
4. Notification of Special Inspection shall be via Special Inspection Request Form submitted to Contractor 48 hours prior to needed inspection time.
5. Subcontractor: Subcontractor, supplier, or vendor executing a subcontract or purchase order with Contractor.

B. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and reference standards.
2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in the area where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of work requiring Special Inspection by an approved Special Inspector who is present in the area where the Work has been or is being performed, and at the completion of the Work.

C. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.
2. Requirements are indicated on Statement of Special Inspections (Plan) provided in the Contract Documents.
3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces by a registered design professional for general conformance to Contract Documents.

1.3 STATEMENT OF SPECIAL INSPECTIONS (PLAN) REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated under IBC Section 1705: None required.
2. Wind-force-resisting systems designated under IBC Section 1705: Required.
3. Architectural, Mechanical, and Electrical Components subject to Special Inspection and testing under IBC Section 1705 for Seismic Resistance: None Required.

B. Statement of Special Inspections (Plan): As included in the Contract Documents and in support of the building permit application. The following identifies elements of the inspection, observation, and testing program to be followed in construction of the Work:

1. Special Inspection and testing required by IBC Section 1705 and other applicable sections and referenced standards therein.
2. Type and frequency of Special Inspection required.
3. Type and frequency of testing required.
4. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to the required recipients.
5. Geotechnical Observation to be Performed: Required frequency and distribution of Geotechnical Observation reports by registered design professional to the required recipients.

C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an Approved Testing Agency.

D. Contractor's plan for code required Special Inspection with associated testing, as provided in Statement of Special Inspections (Plan) in the Contract Documents and further provided in the Section, is for the sole benefit of Contractor and does not:

1. Relieve Subcontractor of responsibility of providing adequate quality control measures.

2. Relieve Subcontractor of responsibility for damage to or loss of material before acceptance.
 3. Constitute or imply acceptance.
 4. Affect continuing rights of Contractor/Owner after acceptance of completed Work.
- E. The presence or absence of code required Special Inspector and/or Contractor does not relieve Subcontractor from Contract requirements.
- F. Subcontractor is responsible for additional costs associated with Special Inspection and Testing and Observation when Work is not ready at time identified by Subcontractor and Special Inspectors and/or Contractor are on site but not able to provide contracted services.
- G. Subcontractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and/or Professional Observers required due to rejection of materials of in place Work that cannot be made compliant to Contract Document without additional Site visits or testing.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 CONDUCTING TESTING

- A. Provide access to shop or Site for Inspection and Testing and Professional Observation.
- B. Notify Contractor in advance of required Special Inspection and Professional Observation no later than 2 working days prior to date of Special Inspection and Professional Observation via the Special Inspection Request Form.
- C. Materials and systems, inclusive, shall be inspected during placement where Continuous Special Inspection is required.
- D. Materials and systems shall be inspected during or at completion of their placement where Periodic Special Inspection is allowed.
 1. Periodic Special Inspection shall be performed so that Work inspected after, but not during, its placement can be corrected prior to other related Work proceeding and covering inspected Work.
 2. Periodic Special Inspection does not allow sampling of a portion of the Work. All Work shall be inspected.

3.2 SUPPLEMENT

- A. The supplement listed below, following “End of Section,” is a part of this Specification:
 1. Special Inspection Request Form.

END OF SECTION 014580

SPECIAL INSPECTION REQUEST FORM

SUBCONTRACTOR:

Insert Name

DATE:

Insert Date

INSPECTION NEEDED DATE:

Insert Date

TIME:

Insert Time

LOCATION / AREA

Insert Name

INSPECTION TYPE:

Insert Type

- ☐ 48-Hour Notice
- ☐ Emergency Short Notice
- ☐ For Special Inspection
- ☐ For Professional Observation

All work must be pre-inspected by Subcontractor prior to special inspection unless agreed to by Contractor. Failure to pre-inspect or failure of inspection of the work may result in back charges against the requesting Subcontractor for Special Inspection Services as described in Section 014580, Special Inspection, Observation, and Testing. Article Statement of Special Inspections (Plan) Requirements.

THE WORK IS:

- ☐ Complete but questions remain open and need to consult with the Inspector onsite
- ☐ Ready for a Segment or Progress Inspection
- ☐ Ready for Final Inspection
- ☐ Ready for Reinspection

THE WORK IS:

- ☐ Change Order Work, PID, or DCN #
- ☐ Contract Work
- ☐ Other

REQUESTED BY SUBCONTRACTOR

By: _____ Title: _____

Date: _____

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.
- B. Related Requirements:
 - 1. Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
 - 2. Section 017700 "Closeout Procedures" for final cleaning.
 - 3. Section 312319 "Dewatering" for disposal of ground water at Project site.

1.2 USE CHARGES

- A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Engineer, testing agencies, and authorities having jurisdiction.
- B. Water Service: Owner will pay water-service use charges for water used by all entities for construction operations.
- C. Electric Power Service: Owner will pay electric-power-service use charges for electricity used by all entities for construction operations.
- D. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- E. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.3 INFORMATIONAL SUBMITTALS

- A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.
- B. Implementation and Termination Schedule: Within **30** calendar days of Notice to Proceed date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

- C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.
- D. Provide erosion and sedimentation plan.
- E. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.
- F. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.
- G. Dust: Submit coordination drawing and narrative that indicates the dust control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:
 - 1. Locations of dust-control partitions at each phase of work.
 - 2. Waste-handling procedures.
 - 3. Other dust-control measures.

1.4 QUALITY ASSURANCE

- A. Temporary facilities shall comply with all applicable state and local ordinances, codes and regulations.
- B. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- D. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.

- B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide **concrete** bases for supporting posts.
- C. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain link fence, sized to height of fence, in color selected by Engineer from manufacturer's standard colors.
- D. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E 84 and passing NFPA 701 Test Method 2.
- E. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats minimum 36 by 60 inches.
- F. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

2.2 TEMPORARY FACILITIES

- A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
- B. Design Builder/Engineer's Field Office: Of sufficient size, but minimum 12-ft by 50-ft, to accommodate needs of Engineer, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections for duration of project.

PART 3 - EXECUTION

3.1 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
- C. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Final Completion, restore these facilities to condition existing before initial use.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- G. The Contractor shall furnish temporary light and power, including 220 Volt service for welding, complete with wiring, lamps and similar equipment as required to adequately light all work areas and with sufficient power capacity to meet the project needs. Make all necessary arrangements with the local electric company for temporary electric service and pay all expenses in connection therewith.
- H. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- I. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
 - 1. Install electric power service overhead unless otherwise indicated.
 - 2. Connect temporary service to Owner's existing power source, as directed by Owner.
- J. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
- K. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment and one land-based telephone line(s) for each field office.

3.2 SUPPORT FACILITIES INSTALLATION

- A. Traffic Controls: Comply with requirements of authorities having jurisdiction.
 - 1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 - 2. Maintain access for fire-fighting equipment and access to fire hydrants.

- B. Parking: Provide temporary parking areas for construction personnel.
- C. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- D. Project Signs: Provide Project signs as indicated.
- E. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."
- F. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."
- G. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - 1. Comply with work restrictions specified in Section 011000 "Summary."
- B. Temporary Erosion and Sedimentation Control: Comply with requirements of authorities having jurisdiction requirements specified in Section 311000 "Site Clearing."
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings or authorities having jurisdiction, whichever is more stringent.
 - 1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
 - 2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
 - 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 - 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

- E. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."
- F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- G. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- H. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
- J. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
 - 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 - 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

END OF SECTION 015000

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.
- B. Related Requirements:
 - 1. Section 012500 "Substitution Procedures" for requests for substitutions.
 - 2. Section 014200 "References" for applicable industry standards for products specified.

1.2 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved by Engineer through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.
- C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that

does meet the requirements of the specifications. Submit a comparable product request, if applicable.

- D. Days: Business days unless noted otherwise.

1.3 ACTION SUBMITTALS

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
 2. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within **[seven]** days of receipt of a comparable product request. Engineer will notify Contractor of approval or rejection of proposed comparable product request within **[15]** days of receipt of request, or **[seven]** days of receipt of additional information or documentation, whichever is later.
 - a. Form of Engineer's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
 - b. Use product specified if Engineer does not issue a decision on use of a comparable product request within time allocated.
- B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.4 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used.
- B. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.
1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

- a. Name of product and manufacturer.
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.
3. See individual identification sections in Divisions 21, 22, 23, and 26 for additional identification requirements.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 1. Store products to allow for inspection and measurement of quantity or counting of units.
 2. Store materials in a manner that will not endanger Project structure.
 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 6. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
 2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
 4. Where products are accompanied by the term "as selected," Engineer will make selection.
 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
 6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.
 - a. Submit additional documentation required by Engineer in order to establish equivalency of proposed products. Evaluation of "or equal" product status is by the Engineer, whose determination is final.
- B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.

Comparable products or substitutions for Contractor's convenience will not be considered.

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
 5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
 6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
 7. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.
- C. Visual Selection Specification: Where Specifications include the phrase "as selected by Engineer from manufacturer's full range" or similar phrase, select a product that complies with requirements. Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer may return requests without action, except to record noncompliance with these requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
 2. Evidence that proposed product provides specified warranty.
 3. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.
 4. Samples, if requested.

- B. Submittal Requirements: Approval by the Engineer for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 016000

SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Salvaging nonhazardous waste.
 - 2. Recycling nonhazardous demolition and construction waste.
 - 3. Disposing of nonhazardous demolition and construction waste.
- B. Related Requirements:
 - 1. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
 - 2. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.2 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building, structure, and site improvement materials resulting from demolition operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Provide handling, containers, storage, signage, transportation, and other items as required.
 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

3.2 SALVAGING DEMOLITION WASTE

- A. Comply with requirements in the drawings for salvaging demolition waste.

3.3 RECYCLING DEMOLITION WASTE

- A. Asphalt Paving: Grind asphalt to maximum [**4-inch**] size.
 1. Crush asphaltic concrete paving and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill.
- B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.
- C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
 1. Pulverize concrete to maximum [**4-inch**] size.
 2. Crush concrete and screen to comply with requirements in Section 312000 "Earth Moving" for use as satisfactory soil for fill or subbase.
- D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
 1. Pulverize masonry to maximum [**4-inch**] size.
 2. Clean and stack undamaged, whole masonry units on wood pallets.
- E. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

3.4 DISPOSAL OF WASTE

- A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
 - 1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.
- C. Burning: Do not burn waste materials.

END OF SECTION 017419

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Substantial Completion procedures.
 - 2. Final completion procedures.
 - 3. Warranties.
 - 4. Final cleaning.
 - 5. Repair of the Work.
- B. Related Requirements:
 - 1. Section 013233 "Photographic Documentation" for submitting final completion construction photographic documentation.
 - 2. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
 - 3. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 4. Section 017900 "Demonstration and Training" for requirements to train the Owner's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 Definitions

- A. Days: Business days unless otherwise noted.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of cleaning agent.
- B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.
- C. Certified List of Incomplete Items: Final submittal at final completion.

1.4 CLOSEOUT SUBMITTALS

- A. Certificates of Release: From authorities having jurisdiction.
- B. Certificate of Insurance: For continuing coverage.
- C. Field Report: For pest control inspection.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.6 SUBSTANTIAL COMPLETION PROCEDURES

- A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.
- B. Submittals Prior to Substantial Completion: Complete the following a minimum of [5] days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
 - 2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
 - 3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 - 4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.
 - a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Design Builder's signature for receipt of submittals.
 - 5. Submit testing, adjusting, and balancing records.
 - 6. Submit sustainable design submittals not previously submitted.
 - 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
- C. Procedures Prior to Substantial Completion: Complete the following a minimum of [2] days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
 - 1. Advise Owner of pending insurance changeover requirements.
 - 2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 - 3. Complete startup and testing of systems and equipment.
 - 4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
 - 5. Advise Owner of changeover in utility services.

- D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of [3] days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.
 - 1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 - 2. Results of completed inspection will form the basis of requirements for final completion.

1.7 FINAL COMPLETION PROCEDURES

- A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:
 - 1. Submit a final Application for Payment.
 - 2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
 - 3. Submit final completion photographic documentation.
- B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Design Builder will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.8 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1.9 SUBMITTAL OF PROJECT WARRANTIES

- A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Owner's rights under warranty.

- B. Partial Occupancy: Submit properly executed warranties within [15] days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.
- D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.
- E. Warranties in Paper Form:
 - 1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
 - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
 - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

3.2 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

- B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
 - a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.
- B. Related Requirements:
 - 1. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.2 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.3 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Engineer will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit by uploading to web-based project software site. Enable reviewer comments on draft submittals.
- C. Initial Manual Submittal: Submit draft copy of each manual at least **[15]** days before commencing demonstration and training. Engineer will comment on whether general scope and content of manual are acceptable.

- D. Final Manual Submittal: Submit each manual in final hard copy form prior to requesting inspection for Substantial Completion and at least **[10]** days before commencing demonstration and training.
 - 1. Correct or revise each manual to comply with Engineer's comments. Submit copies of each corrected manual within **[15]** days of receipt of Engineer's comments and prior to commencing demonstration and training.
- E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.4 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Final Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, **[loose-leaf]** binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 - 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 - 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.

4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.5 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 1. Title page.
 2. Table of contents.
 3. Manual contents.
- B. Title Page: Include the following information:
 1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Design Builder
 7. .
 8. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
 9. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents.

1.6 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.7 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.8 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
 - 1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 - 2. Performance and design criteria if Contractor has delegated design responsibility.
 - 3. Operating standards.
 - 4. Operating procedures.
 - 5. Operating logs.
 - 6. Wiring diagrams.
 - 7. Control diagrams.
 - 8. Piped system diagrams.
 - 9. Precautions against improper use.
 - 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
 - 1. Product name and model number. Use designations for products indicated on Contract Documents.
 - 2. Manufacturer's name.
 - 3. Equipment identification with serial number of each component.
 - 4. Equipment function.
 - 5. Operating characteristics.
 - 6. Limiting conditions.
 - 7. Performance curves.
 - 8. Engineering data and tests.
 - 9. Complete nomenclature and number of replacement parts.
- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures.

- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.9 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.
- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
 2. Troubleshooting guide.
 3. Precautions against improper maintenance.
 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 5. Aligning, adjusting, and checking instructions.
 6. Demonstration and training video recording, if available.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
1. Do not use original project record documents as part of maintenance manuals.
- 1.10 PRODUCT MAINTENANCE MANUALS
- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 - 1. Inspection procedures.
 - 2. Types of cleaning agents to be used and methods of cleaning.
 - 3. List of cleaning agents and methods of cleaning detrimental to product.
 - 4. Schedule for routine cleaning and maintenance.
 - 5. Repair instructions.
- F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017823

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for project record documents, including the following:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.
- B. Related Requirements:
 - 1. Section 017300 "Execution" for final property survey.
 - 2. Section 017700 "Closeout Procedures" for general closeout procedures.
 - 3. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.2 CLOSEOUT SUBMITTALS

- A. Record Drawings: Comply with the following:
 - 1. Number of Copies: Submit **[one]** set(s) of marked-up record prints.
 - 2. Number of Copies: Submit copies of record Drawings as follows:
 - a. Initial Submittal:
 - 1) Submit **[one]** paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and **[one]** of file prints.
 - 3) Engineer will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit **[three]** paper-copy set(s) of marked-up record prints.
 - 2) Submit PDF electronic files of scanned record prints and **[three]** set(s) of prints.
 - 3) Print each drawing, whether or not changes and additional information were recorded.
 - c. Final Submittal:
 - 1) Submit **[one]** paper-copy set(s) of marked-up record prints.
 - 2) Submit record digital data files and **[three]** set(s) of record digital data file plots.

- 3) Plot each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.
 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report monthly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.3 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.
 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross-reference record prints to corresponding photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Work Change Directive.
 - k. Changes made following Engineer's written orders.
 - l. Details not on the original Contract Drawings.

- m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 - 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
 - 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 - 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Final Completion, review marked-up record prints with Engineer. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:
- 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
 - 2. Format: [DWG] [DXF], Microsoft Windows operating system.
 - 3. Format: Annotated PDF electronic file with comment function enabled.
 - 4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 - 5. Refer instances of uncertainty to Engineer for resolution.
 - 6. Engineer will furnish Contractor with one set of digital data files of the Contract Drawings for use in recording information.
 - a. See Section 013100 "Project Management and Coordination" for requirements related to use of Engineer's digital data files.
 - b. Engineer will provide data file layer information. Record markups in separate layers.
- C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
- 1. Record Prints: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 - 2. Format: Annotated PDF electronic file with comment function enabled.
 - 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 - 4. Identification: As follows:
 - a. Project name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWINGS."
 - d. Name of Engineer.
 - e. Name of Contractor.

1.4 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 - 3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 - 4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 - 5. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file.

1.5 RECORD PRODUCT DATA

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
 - 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 - 2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
 - 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- C. Format: Submit record Product Data as annotated PDF electronic file.
 - 1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

1.6 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.
- B. Format: Submit miscellaneous record submittals as PDF electronic file.
 - 1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.7 MAINTENANCE OF RECORD DOCUMENTS

- A. Maintenance of Record Documents: Store record documents in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Engineer's and Construction Manager's reference during normal working hours. As a prerequisite for monthly progress payments, exhibit the updated record documents for review by Owner and Engineer for accuracy and completeness.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017839

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Instruction in operation and maintenance of systems, subsystems, and equipment.
 - 2. Demonstration and training video recordings.
 - 3. Days: Business days unless otherwise noted.

1.2 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For instructor.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.
- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

1.3 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit [**one**] copies within [**seven**] days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Design-Builder.
 - d. Date of video recording.

1.4 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of Owner's personnel.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Engineer.

1.5 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Systems and equipment operation & maintenance manuals.
 - b. Project Record Documents.
 - c. Identification systems.
 - d. Warranties and bonds.
 - e. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
 - a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
 - a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
 - a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning.
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
 - a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

1.6 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
- B. Set up instructional equipment at instruction location.

1.7 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Owner for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 3. Owner will furnish Contractor with names and positions of participants.
- C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner, through Engineer and Design Builder, with at least **[seven]** Insert number days' advance notice.
- D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
- E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of **[a demonstration]** performance-based test.
- F. Cleanup: Collect used and leftover educational materials and. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017900

SECTION 024119 - DEMOLITION AND ABANDONMENT

PART 1 - GENERAL

1.1 SITE PREPARATION, CLEAN UP, AND RESTORATION

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Demolition and Abandonment – Section 407.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 024119

SECTION 030100.61 - CONCRETE REPAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. JEA Water & Wastewater Standards (latest edition).

1.2 SUMMARY

- A. Section includes concrete repair consisting of the following:
 - 1. Removal of existing concrete.
 - 2. Bonding new concrete.
 - 3. Repair mortar.
 - 4. Crack and leaking construction joint repair (polyurethane chemical grout injection).
 - 5. Crack repair (epoxy adhesive injection).
 - 6. Spalled, deteriorated, and disintegrated concrete repair.
 - 7. Surface waterstop repair.
 - 8. Sealing of joints between existing and new concrete.
- B. Related Requirements:
 - 1. Section 024119 "Demolition and Abandonment" for partial removal of various building components and systems.
 - 2. Section 031000 "Concrete Forming and Accessories" for concrete formwork.
 - 3. Section 031500 "Concrete Joints and Accessories" for concrete joints and joint accessories.
 - 4. Section 033000 "Cast-in-Place Concrete for ground and elevated cast concrete.
 - 5. Section 030130.71 "Modifications to Existing Concrete" for modifying existing concrete.
 - 6. Section 050519 "Post-Installed Anchors and Reinforcing Bars" for testing of drilled in injection adhesive anchor system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Including manufacturers printed performance criteria, product life, working time after mixing, surface preparation and application requirements and procedures, curing, and volatile organic compound data.
 - 2. Storage requirements including temperature, humidity, and ventilation.
 - 3. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for:
 - a. Polyurethane chemical grout.

- b. Crack repair epoxy adhesive.
- c. Epoxy bonding agent.
- d. Repair mortars.
- e. Surface waterstop repair.
- f. Backer rods.
- g. Epoxy adhesive paste.

- 4. Include rated capacities, operating characteristics, and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Product Certificates: Notarized certificate for each repair material stating that product meets requirements of this Section and has manufacturer's current printed literature on product package or container.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company with a minimum of 10 years' documented experience and having an ongoing program to train, certify, and technically support installers.
- B. Installer Qualifications: Fabricator of products.
- C. Contractor's Supervisor: Having attended a training program sponsored by manufacturer supplying project approved materials.
- D. Testing Agency Qualifications: Qualified according to ASTM C 1021 for testing indicated and accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC Standard 17025.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Deliver materials in original, new, and unopened packages and containers clearly labeled with information referenced in Division 01 and the following information:
 - 1. Manufacturer's stock number and batch number.
 - 2. Date of manufacture.
 - 3. Expiration or use-by date.
- B. Storage of Materials:
 - 1. Store only approved materials on site.

1.7 FIELD CONDITIONS

- A. Conform to temperatures and other environmental factors as stated within manufacturer's published installation instructions for storage, substrate conditions, application, curing, and other procedures required by work of this Section.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Use materials in compliance with state and local regulations.

2.2 MATERIALS

- A. Polyurethane Chemical Grout:
 - 1. Single component, expanding, moisture reactive polyurethane grout designed to seal cracks and open joints in concrete. Provide cured chemical grout that forms a compressed closed cell urethane foam that completely fills the crack or joint.
 - 2. Accelerator: May be used if recommended by approved polyurethane chemical grout manufacturer.
 - 3. Provide injection packers for application of polyurethane chemical grout.
 - 4. Acceptable Manufacturers and Products, provide one of the following:
 - a. BASF Corporation: Master Inject 1210 IUG.
 - b. Sika Corporation: SikaFix HH Hydrophilic.
 - c. GCP Applied Technologies.: DE NEEF HA Multigel NF.
- B. Crack Repair Epoxy Adhesive:
 - 1. ASTM C 881/ C 881M, Type V, Grade 2, Class C; two-component, solvent-free, moisture insensitive epoxy resin material suitable for repairing cracks in concrete by injection or gravity feed; formulated for specific size of opening or crack being injected.
 - 2. Acceptable Manufacturers and Products, provide one of the following:
 - a. Euclid Chemical Company: EUCO #452.
 - b. Five Star Products Inc.: Bonding Adhesive.
 - c. Sika Corporation: Sikadur 35, Hi Mod LV.

C. Epoxy Bonding Agent:

1. Two-component, solvent-free, asbestos-free moisture insensitive epoxy resin material used to bind plastic concrete to hardened concrete and complying with requirements of ASTM C 881, Type V, Grade 2, Class C.
2. Acceptable Manufacturers and Products, provide one of the following:
 - a. Euclid Chemical Company: Dural 452 MV.
 - b. Sika Corporation: Sikadur 32, Hi Mod.
 - c. Simpson Strong-Tie Company Inc.: FX-752.

D. Horizontal Repair Mortars:

1. Concrete Surfaces to Receive a Protective Coating System (Wet Wells, Channels, Box and Related Wastewater Structures): Rapid hardening portland cement-based repair mortar with extended working time.
 - a. Acceptable Manufacturer and Product per JEA Water & Wastewater Standard 448: SikaQuick-1000 by Sika Corporation.
2. All Other Horizontal Concrete Surfaces: Two-component polymer-modified, portland cement-based mortar used to repair horizontal surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 7,000 psiat 28 days tested in accordance with ASTM C 881 or ASTM C 109.
 - a. Acceptable Manufacturers and Products, provide one of the following:
 - b. BASF Corporation: MasterEmaco T 310CI.
 - c. Euclid Chemical Company: DuralTop Flowable Mortar.
 - d. Sika Corporation: SikaTop 122 Plus.

E. Vertical and Overhead Repair Mortars:

1. Concrete Surfaces to Receive a Protective Coating System (Wet Wells, Channels, Box and Related Wastewater Structures): Fast setting, one component portland cement-based repair mortar with high build properties.
 - a. Acceptable Manufacturer and Product per JEA Water & Wastewater Standard 448: SikaQuick VOH by Sika Corporation.
2. All Other Vertical Concrete Surfaces: Two-component polymer-modified, portland cement based, fast setting, non-sag mortar used to repair vertical and overhead surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 5,000 psiat 28 days tested in accordance with ASTM C 881 or ASTM C109.
 - a. Acceptable Manufacturers and Products, provide one of the following:
 - b. Euclid Chemical Company: DuralTop Gel.
 - c. Sika Corporation: SikaTop 123 Plus.
 - d. US SPEC: H2.

F. Epoxy Paste Adhesive:

1. Two-component, solvent-free, moisture insensitive epoxy resin material used as an adhesive for mating surfaces where the glue line is 1/8 inch or less and to bond fresh, plastic concrete to clean, sound hardened concrete and complying with requirements of ASTM C 881, Type IV, Grade 3, Class C.
2. Test Data: Base test upon material and curing condition of 73 plus/minus two degrees F and 50 plus/minus five percent Relative Humidity.
3. Acceptable Manufacturers and Products, provide one of the following:
 - a. Sika Corporation: Sikadur 31 Hi-Mod Gel.
 - b. Euclid Chemical Company: Dural 452 Gel.
 - c. BASF Corporation: MasterEmaco ADH 1420.

2.3 ACCESSORY MATERIALS

A. Backer Rods:

1. Open Cell Backer Rod: Extruded, open cell polyurethane foam. Diameter shall not be less than 200 percent of the joint width dimension.
2. Closed Cell Backer Rod: Extruded, non-staining, resilient closed cell polyethylene foam, compatible with sealant. Diameter shall not be less than 25 percent greater than the joint width. Sealant shall not adhere to backer rod.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, and installation tolerances affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Manufacturer's Representative: Be present for first three days of installation to give instructions to installation crew and then make periodic site visits to ensure products are being installed in accordance with published instructions.
- B. When removing materials or portions of existing structures and when making openings in existing structures, erect barriers, shoring and bracing, and other protective devices to prevent damage to structures beyond the limits of new work, protect personnel, control dust, and prevent damage by falling or flying debris. Comply with requirements of Section 015000 "Temporary Facilities and Controls."

3.3 GENERAL

- A. Store, mix, apply, and cure materials for each repair system in strict compliance with manufacturer's installation instructions. Make repairs necessary, without additional compensation, so completed work complies with Contract Document work scopes.
- B. Where concrete is repaired near an expansion joint or control joint, preserve isolation between components on either side of the joint.
- C. Identify reinforcing locations prior to drilling using reinforcing bar locators so that drill hole locations may be adjusted to avoid reinforcing interference. When drilling holes for dowels and bolts, stop drilling if reinforcing is encountered. Relocate hole to avoid reinforcing as approved by the Engineer. Do not cut reinforcing without prior approval by the Engineer.
- D. Concrete designated to be removed to specific limits indicated or directed by the Engineer, shall be done by saw cutting (1 inch deep) at limits of removal followed by line drilling, chipping, sandblasting, or airblasting, as appropriate in areas where deteriorated, damaged, or unsound concrete is to be removed. Remove concrete such that surrounding concrete and existing reinforcing to be left in place and existing in place equipment are not damaged.
 - 1. Perform full thickness saw-cutting at limits of concrete to be removed only if indicated, specified, or after obtaining written approval from the Engineer.
- E. Saw-cut edges straight for vertically and horizontally repair areas. Make intersecting cuts perpendicular to each other.
- F. Stop saw cutting if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Identify reinforcing locations within one foot of saw cut locations in any direction prior to saw cutting using reinforcing bar locators.
- G. Clean concrete surfaces of efflorescence, deteriorated concrete, dirt, laitance, and existing repair materials such as liners, adhesives, and epoxies. Remove foreign matter and deleterious films by sandblasting, airblasting, scarifying or other mechanical means to sound original concrete.
- H. Thoroughly clean repair area with oil-free compressed air, then install bonding agent. Place repair materials within open time of epoxy bonding agent.
- I. Consolidate repair material, completely filling all portions of area to be filled.
- J. Bring finished repair surfaces into alignment with adjacent existing surfaces to provide a uniform, flush, and even surface. Match repair surfaces to adjacent existing surfaces in texture, including any coatings or surface treatments that had been provided for existing surface.
- K. Remove excess material from faces of materials being repaired and adjacent walls, floors, and slabs. Leave exposed faces of surface materials clean and ready to accept subsequent work.
- L. Repair or replace concrete indicated or specified to be left in place, but that is damaged because of the work of this Section. Perform work by approved means and methods.

3.4 CRACK AND CONSTRUCTION JOINT REPAIR (POLYURETHANE CHEMICAL GROUT INJECTION REPAIR)

- A. Apply polyurethane chemical grout to leaking cracks, joints, and voids in existing concrete.
- B. Install polyurethane chemical grout through drilled-in injection ports installed as recommended by polyurethane chemical grout manufacturer. Install and cure polyurethane repair materials in accordance with manufacturer's requirements.
- C. Remove injection ports and seal with grout. Leave repair area flush with surrounding concrete surfaces.

3.5 CRACK REPAIR (EPOXY ADHESIVE INJECTION REPAIR)

- A. Repair cracks on horizontal surfaces by gravity feeding crack repair epoxy adhesive into cracks. Pressure inject cracks less than 1/16 inch in thickness.
- B. Repair cracks on vertical surfaces by pressure injecting crack repair epoxy adhesive through injection ports sealed to surface with crack repair epoxy adhesive.
- C. Clean cracks by sandblasting, water jet, or high-pressure oil free air to remove loose matter, dirt, laitance, oil, grease or other contaminants. Prior to injection of the crack apply a surface seal of epoxy paste to crack faces.
 - 1. Establish openings in surface seal (injection ports) along the crack. Do not allow distance between injection ports to be greater than slab or wall thickness.
 - 2. Begin injection at first port at one end of the crack. For vertical or inclined surfaces begin injection at lowest point of the crack. Continue injection at first port until injected epoxy begins to flow out of second port in line.
 - 3. Plug first port and continue injection from second port. Inject entire crack following same sequence. Continue injecting crack and do not stop until crack is completely injected.
 - 4. After injected epoxy has cured, remove or cut off ports and grind flush with adjacent concrete surface. Do not allow indentations or protrusions caused by port placements.

3.6 SPALLED/DETERIORATED CONCRETE REPAIR

- A. Only use polymer-modified cementitious repair mortar for surface repair of spalled or deteriorated concrete.
- B. Comply with manufacturer's recommendations for concrete removal, surface preparation, mixing, application, lift thickness, finishing, moist curing, and form removal.
- C. Saw cut perimeter of deteriorated concrete to form a rectangle with straight edges to depth indicated. Remove fractured, loose, broken, softened, and deteriorated concrete by abrasive blasting, chipping, or other appropriate means to sound concrete. Chip concrete substrate to obtain a surface profile with a new fractured aggregate surface.
- D. Remove dirt, oil, grease, and other bond inhibiting materials from surface by dry mechanical means such as sand blasting, chipping, or wire brushing. Thoroughly clean surface of loose or

weakened material and dust by dry mechanical means such as oil-free air blast. Follow recommendations of repair mortar manufacturer for additional surface preparation.

- E. Do not damage reinforcing steel that is to be incorporated into new concrete. Where reinforcing steel with active corrosion is encountered, use following procedure:
 - 1. Use dry mechanical means to remove loose material, contaminants and rust from exposed reinforcing steel.
 - 2. When more than half of reinforcing bar diameter is exposed, chip out behind reinforcing steel, 1 inch minimum.
 - 3. Make distance chipped behind a reinforcing bar equal to or exceed minimum placement depth of material being used, 1 inch minimum.
 - 4. If existing reinforcing steel has lost more than 15 percent of its original cross-sectional area, splice in new reinforcing with standard lap splice or mechanical connector to sound reinforcement.
- F. Repair cracks encountered in substrate area of spalled or deteriorated concrete repair as specified and directed by the Engineer.
- G. Repair Mortar Placement:
 - 1. Follow procedures recommended by manufacturer for mixing and placement of repair mortar.
 - 2. After initial mixing of repair mortar, do not add water to change the consistency, should the mix begin to stiffen.
 - 3. Saturate substrate surface dry (SSD) with no standing water during application.
 - 4. Apply scrub coat to substrate, filling all pores and voids.
 - 5. While scrub coat is still plastic, apply polymer-modified repair mortar. Place repair mortar to an even, uniform plane to restore the member to its original surface.
 - 6. For applications greater than 1 inch in depth, apply repair mortar in lifts. Score exposed surface of each lift to produce a roughened surface before applying the next lift. Allow lift to reach final set before proceeding with subsequent lift.
- H. Finishing:
 - 1. Apply repair mortar with a smooth, steel trowel finish, unless otherwise noted.
 - 2. Have no sharp edges when repair is completed. Make exterior corners, such as at penetrations, with a 1 inch radius. Make interior corners square.
- I. Curing: Perform as recommended by repair mortar manufacturer, except that cure period shall be at least 24 hours and done by means of a continuous fog spray or moist cure with wet burlap.
- J. Repairs Requiring Formwork:
 - 1. Remove fractured, loose, deteriorated, and unsound concrete by bush hammering, chipping, high pressure water blast, or other appropriate dry mechanical means. Remove dirt, oil, grease, and other bond inhibiting materials from concrete surface.
 - 2. Treat existing anchor bolts, exposed reinforcing steel, and reinforcing to be incorporated into repair mortar, as specified below.
 - 3. Construct leakproof forms as required by project conditions. Line or coat forms with release agents recommended by repair mortar manufacturer. Provide forms of adequate

strength, securely anchored in place and shored to resist the forces imposed by repair mortar and its placement.

4. Saturate existing concrete surfaces with water, with no standing water during application. Prime concrete surface with a scrub coat of repair mortar. Restore area to original limits or as shown using repair mortar before scrub coat dries. Extend repair mortar with 3/8 inch aggregate only as recommended by manufacturer of repair mortar.

3.7 FIELD QUALITY CONTROL

- A. At completion of repairs, Contractor, Engineer, and material Installer shall meet to inspect installed work. Repair leaking joints, cracks, or voids in accordance with manufacturer's instructions. At completion of various repairs, Contractor, Engineer, and Installer shall reinspect repaired problem areas. Make subsequent repairs until work is in conformance with Contract Documents.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Perform the following tests and inspections:
 1. Mortar cubes
 2. Adhesion
 3. Spark for coatings
 4. Dry film thickness.
- D. Repair mortar will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 030100.61

SECTION 030130.71 - MODIFICATIONS TO EXISTING CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:

1. Cutting, removing, or modifying parts of existing concrete structures or appurtenances.
2. Addressing existing steel reinforcing bars encountered.
3. Bonding new concrete or grout to existing concrete.

- B. Related Requirements:

1. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.
2. Section 024119 "Demolition and Abandonment" for selective demolition and modification procedures.
3. Section 030100.61 "Concrete Repairs" for repair materials and related repair work.
4. Section 031000 "Concrete Forming and Accessories" for formwork and related repair work.
5. Section 032000 "Concrete Reinforcing" for reinforcing and related repair work.
6. Section 033000 "Cast-In-Place Concrete" for concrete materials, and related work.
7. Section 031500 "Concrete Joints and Accessories" for related work.
8. Section 033500 "Concrete Finishing" for related work.
9. Section 036000 "Grouting" for grout and related accessories.
10. Section 050519 "Post-Installed Anchors" for anchors and related accessories.
11. Section 055000 "Miscellaneous Metals" for various metals and related fabrications.

1.3 ACTION SUBMITTALS

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

1. Submit manufacturer's technical literature and installation instructions that include:
 - a. Current printed recommendations and product data sheets for products including performance criteria, product life, working time after mixing, surface preparation and application requirements and procedures, curing, volatile organic compound data, and safety requirements.
 - b. Storage requirements including temperature, humidity, and ventilation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Documentation of the qualifications for Contractor qualifications, Manufacturer's qualifications, and Contractor's supervisor as specified in Paragraph 1.5.
- B. Retain "Material Certificates" Paragraph below to require submittal of certificates from manufacturers.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Have a minimum of ten years' experience within last 10 years in manufacture and use of specified products and have an ongoing program of training, certifying, and technically supporting Contractor's personnel.
- B. Contractor Qualifications: Complete a program of instruction in application of approved manufacturer's material and provide certification from manufacturer attesting to their training and status as an approved applicator.
- C. Contractor's Supervisor: Have attended a training program sponsored by manufacturer supplying materials approved for this project.
- D. Manufacturer's Representative: A representative of product manufacturer who will visit the site for first three days of installation to give instructions to installation crew. Make periodic site visits to ensure products being installed are in accordance with published instructions.
- E. Do not shift, cut, remove, or otherwise altered existing structure or concrete until authorization is given by the Engineer.
- F. When removing materials from or making openings in existing structures, take precautions and erect necessary barriers, shoring and bracing, and other protective devices. Prevent damage to structures beyond limits necessary for new work, protect personnel, control dust, and to prevent damage to structures or contents by falling or flying debris.
- G. Unless otherwise permitted, shown, or specified, cut existing concrete by line drilling.
- H. Construction Tolerances: Comply with requirements specified elsewhere in Division 03, except as modified herein, and elsewhere in Contract Documents.
- I. Make locations and phases of the work available for access by the Engineer or other personnel designated by the Engineer. Provide ventilation and safe access to the work.
- J. Be solely responsible for workmanship and quality of modification work. Inspections by the manufacturer, the Engineer, or others do not limit Contractor's responsibility for work quality.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials in original, new and unopened packages and containers clearly labeled with the following information:

1. Manufacturer's name.
 2. Name or title of material, and other product identification.
 3. Manufacturer's stock number and batch number.
 4. Date of manufacture.
 5. Instructions.
 6. Expiration date.
- B. Storage: Store products in accordance with manufacturers' published recommendations and the following supplementary requirements:
1. Store only approved materials on site and in locations as directed.
 2. Keep area clean and accessible.
 3. Comply with health and fire regulations including those of the Occupational Safety and Health Administration (OSHA).
- C. Handling: Handle products carefully and in accordance with manufacturers' published recommendations and the following supplementary requirements:
1. Prevent inclusion of foreign materials.
 2. Do not open containers or mix components until necessary preparatory work has been completed and application work will start immediately.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Comply with this Section and applicable state and local regulations.
- B. Epoxy Bonding Agent:
1. Product: Two-component, solvent-free, asbestos-free moisture insensitive epoxy resin material used to bind plastic concrete to hardened concrete and complying with requirements of ASTM C 881, Type V, Grade 2, Class C.
- C. Epoxy Paste Adhesive:
1. Product: Two-component, solvent-free, moisture insensitive epoxy resin material used as an adhesive for mating surfaces where the glue line is 1/8 inch or less and to bond fresh, plastic concrete to clean, sound hardened concrete and complying with requirements of ASTM C 881, Type IV, Grade 3, Class C.
- D. Repair Mortar (Polymer-Modified Portland Cement Mortar):
1. Horizontal Surfaces:
 - a. Product: Two-component polymer-modified, portland cement based mortar used to repair horizontal surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 7,000 psi at 28 days tested in accordance with ASTM C 881 or ASTM C 109.

2. Vertical and Overhead Surfaces:

- a. Product: Two-component polymer-modified, portland cement based, fast setting, non-sag mortar used to repair vertical and overhead surfaces with a migrating corrosion inhibitor and having a minimum compressive strength of 5,000 psi at 28 days tested in accordance with ASTM C 881 or ASTM C 109.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION - GENERAL

- A. Cut, remove, or otherwise modify parts of existing structures or appurtenances as indicated, specified, or as necessary to complete the work. Finishes, joints, reinforcements, sealants, and similar materials are specified in their respective Sections. Install work complying with requirements of this Section and as indicated.
- B. Locations, details, and limits of modifications are indicated on Drawings. Comply with requirements of this Section and as indicated on Drawings.
- C. Examine areas and conditions under which modification work is to be installed, and notify Engineer in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.
- D. Store, mix, apply, and cure materials in strict compliance with manufacturer's instructions.
- E. Where concrete is to be modified near an expansion joint or control joint, preserve isolation between components on either side of the joint.
- F. When drilling holes for dowels and bolts, stop drilling if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Relocate hole to avoid reinforcing as approved by the Engineer.
 - 1. Identify reinforcing locations prior to drilling using reinforcing bar locators so that drill hole locations may be adjusted to avoid reinforcing interference.
- G. Saw-cut edges for modification areas vertically and horizontally straight. Make intersecting cuts perpendicular to each other.

- H. Stop saw cutting if reinforcing is encountered. Do not cut reinforcing without prior approval by the Engineer. Identify reinforcing locations within 1 foot of saw cut locations in any direction prior to saw cutting using reinforcing bar locators.
- I. Clean concrete surfaces of efflorescence, deteriorated concrete, dirt, laitance, and existing repair materials such as liners, adhesives, and epoxies. Remove foreign matter and deleterious films by sandblasting, oil-free air-blasting, scarifying, or other mechanical means to sound original concrete.
- J. Consolidate modification materials, completely filling portions of the area to be filled.
- K. Bring finished surfaces into alignment with adjacent existing surfaces to provide a uniform, flush, and even surface. Match repair surfaces to adjacent existing surfaces in texture including any coatings or surface treatments that had been provided for the existing structure.
- L. Repair or replace concrete indicated or specified to be left in place that is damaged because of the work by approved means without additional compensation.

3.3 CONCRETE REMOVAL

- A. Concrete designated to be removed to specific limits indicated or directed by the Engineer, perform saw cutting 1 inch deep at limits of removal followed by line drilling and chipping, sandblasting, or oil-free airblasting, as appropriate in the areas where concrete is to be taken out. Remove concrete such that surrounding concrete and existing reinforcing to be left in place and existing in place equipment are not damaged.
 - 1. Perform full thickness saw-cutting at limits of concrete to be removed only if indicated, herein specified, or after obtaining written approval from the Engineer.
- B. Where existing reinforcing is exposed due to saw cutting or line drilling and no new material is to be placed on cut surface, apply a 1/4 inch thick surface treatment of epoxy paste to entire cut surface.
- C. Where joint between new concrete or grout and existing concrete will be exposed in finished work, remove concrete edge by making a 1 inch deep saw cut on each exposed surface of existing concrete or as indicated.

3.4 CONNECTION SURFACE PREPARATION

- A. Concrete areas requiring patching, repairs, or modifications, prepare connection surfaces as specified, as indicated, or as directed by the Engineer.
- B. Remove loose and deteriorated materials, efflorescence, existing repair materials, dirt, oil, grease, and other bond inhibiting materials from concrete surface by dry mechanical means such as sandblasting, chipping, wire brushing, or other mechanical means as approved by the Engineer.

1. Uniformly roughen concrete surface to approximately 1/4 inch amplitude with pointed chipping tools. Thoroughly clean surface of loose or weakened material by sandblasting or air-blasting.
 2. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete.
- C. If reinforcing steel is exposed, mechanically clean to remove loose material, contaminants, and rust as approved by the Engineer. If half of reinforcing steel diameter is exposed, chip out behind the steel. Chip distance behind the steel to a minimum of 1 inch. Do not damage reinforcing to be incorporated in new concrete or repair mortar during removal operation.
- D. Clean reinforcing from existing removed or deteriorated concrete that is shown to be incorporated in new concrete or repair mortar by mechanical means to remove loose material and products of corrosion before proceeding. Cut, bend, or lap to new reinforcing as indicated and provide with 1 inch minimum clear cover.
- E. Use following specific concrete surface preparation Methods where indicated, specified, or as directed by the Engineer:
1. Method A:
 - a. Roughen and clean existing concrete surface at connection.
 - b. Thoroughly saturate surfaces with water; prevent standing water during application.
 - c. Scrub repair mortar into substrate filling concrete pores and voids.
 - d. While scrub coat is still plastic, force repair material against surface. Use epoxy bonding agent if area is too large.
 - e. Place new repair mortar as detailed.
 2. Method B:
 - a. Roughen and clean existing concrete surface at connection.
 - b. Apply epoxy bonding agent at connection surfaces.
 - c. Place new concrete or grout mixture to limits indicated within time constraints recommended by manufacturer to ensure bond.
 3. Method C:
 - a. Use adhesive anchoring system, as specified in Section 050519 "Post-Installed Anchors", for installation of reinforcing steel dowels into existing concrete where indicated.
 - b. Perform installation complying strictly with manufacturer's recommendations, including drill bit diameter, surface preparation, injection, and installation of dowels.
 - c. Drill concrete to embedded deformed bars to indicated depths.
 - d. Use oil-free compressed air to blast out loose particles and dust from drilled holes. Clean dowels to be free of dirt, oil, grease, ice, or other deleterious material that would reduce bond.
 - e. Concrete in existing structures is considered to have a strength of 3,000 psi.

- 4. Method D:
 - a. Combination of Method B & Method C.

3.5 GROUTING

- A. Grout: As specified in Section 036000 "Grouting."

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed installations.
 - 1. Perform inspection with Contractor, material installer, and the Engineer present. Give minimum of 72 hours' notice prior to time of inspection.
 - 2. Repair modifications not in conformance with Contract Documents in accordance with manufacturer's instructions at no additional cost to Owner.
 - 3. At completion of non-conforming repairs, Contractor, material installer, and the Engineer shall reinspect the repaired problem areas.
 - 4. Prepare inspection reports, identifying acceptable work, type and locations of unacceptable work, and actions taken to correct unacceptable work.
 - 5. Complete field quality control work without additional compensation.

END OF SECTION 030130.71

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Formwork for cast-in-place concrete.
2. Shoring, bracing, and anchorage.
3. Architectural form liners.
4. Form accessories.
5. Form stripping.

B. Related Requirements:

1. Section 032000 - Concrete Reinforcing: Reinforcing steel and required supports for cast-in-place concrete.
2. Section 033000 - Cast-in-Place Concrete: Cast-in-place concrete.
3. Section 042000 - Unit Masonry.
4. Section 050519 "Post-Installed Anchors" for testing of drilled in injection adhesive anchor system.
5. Section 055000 - Metal Fabrications: Product requirements for metal fabrications for placement by this Section.
- 6.
7. Various Sections in Divisions 22 and 23: Product requirements for fire suppression, plumbing, and HVAC items for placement by this Section.
8. Various Sections in Division 26: Product requirements for electrical, communications, and security items for placement by this Section.

1.3 COORDINATION

- A. Coordinate Work of this Section with other Sections of Work in forming and placing openings, slots, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

1.4 ACTION SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings:

1. Indicate:

- a. Formwork, shoring, and reshoring.
- b. Pertinent dimensions, openings, details of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
- c. Means of leakage prevention for concrete exposed to view in finished construction.
- d. Notes to formwork erector showing size and location of conduits and piping embedded in concrete according to ACI 318.
- e. Procedure and schedule for removal of shores and installation and removal of reshores.
- f. Location and sequence of concrete placement.
- g. Form release agent.
- h. Form ties.
- i. Bond breakers.

- C. Review of submittals will be for appearance, performance, and strength of completed structure only. Approval by the Engineer will not relieve Contractor of responsibility for the strength, safety, or correctness of methods used, the adequacy of equipment, or from carrying out the work as shown on Contract Documents.

1.5 INFORMATIONAL SUBMITTALS

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

B. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for formwork and shoring.
2. Indicate loads transferred to structure during process of concreting, shoring, and reshoring.
3. Include signed and sealed structural calculations to support design for project records. Calculations will not be reviewed.
4. Submit completed PE Certification Form for design of formwork in accordance with Section 013300. Complete PE Certification Form and stamp by a professional engineer registered in the State where project work site exists.

- C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

D. Qualifications Statement:

1. Submit qualifications for licensed professional.

- E. Certify that form release agent complies with Federal, State and local VOC limitations.

F. Test Reports:

1. Compressive testing of degradable void forms – submit testing data for time-dependent compressive strength loss of degradable void forms exposed to a moist environment.

1.6 QUALITY ASSURANCE

- A. Perform Work according to ACI 347, 301, and 318.
- B. For wood products furnished for Work of this Section, comply with AF&PA.

1.7 SYSTEM DESCRIPTION

- A. Delegated Design Structural Design Responsibility: Provide forms, shoring, and reshoring designed by a professional engineer registered in the State of Florida. Design formwork in accordance with the requirements of ACI 301, ACI 318 and ACI 347. Comply with all applicable regulations and codes. Consider any special requirements due to the use of plasticized and/or retarded set concrete.

1.8 QUALIFICATIONS

- A. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the State of Project location.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

- A. Design, engineer, and construct formwork, shoring, and bracing according to ACI 318, ACI 347,, ACI 347.2R, conforming to Florida Building Code requirements to achieve concrete shapes, lines, and dimensions as indicated and required by project conditions.

2.2 FORMS, GENERAL

- A. Make forms for cast-in-place concrete of wood, steel, or other approved materials. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing.

1. Construct wood forms of sound lumber or plywood free from knotholes and loose knots.
 2. Construct steel forms to produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels.
- B. Provide rigid forms that will not deflect, move, or leak. Design forms to withstand high hydraulic pressures resulting from rapid filling of forms and heavy high frequency vibration of the concrete. Limit deflection to 1/400 of each component span. Lay out form joints in a uniform pattern or as indicated on Drawings.
- C. Dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Tape, gasket, plug, or caulk joints and gaps in forms to provide watertight joints that will withstand placing pressures without exceeding specified deflection limit or creating surface patterns.
- D. Provide 3/4 inch chamfer on form corners unless otherwise indicated.

2.3 FORMS FOR STRUCTURAL CONCRETE

A. Plywood Forms:

1. Make forms for exposed and non-submerged exterior and interior concrete of new and unused Plyform exterior grade plywood panels with B grade or better veneer with High Density Overlay on all faces to be in contact with concrete.
2. Grade: B grade or better.
3. Edges: Clean and true.
4. Exposed Concrete:
 - a. Comply with APA/EWA PS 1.
 - b. Panels: Full size, 4 by 8 feet.
 - c. Label each panel with grade trademark of APA/EWA
5. Surfaces to Receive Membrane Waterproofing:
 - a. Minimum Thickness: 5/8 inch.
 - b. Grade: APA/EWA "B-B Plyform Structural I Exterior."
6. "Smooth Finish" Indicated on Drawings:
 - a. Minimum Thickness: 3/4 inch.
 - b. Grade: APA/EWA "HD Overlay Plyform Structural I Exterior."
7. Design and construct forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing, except as specified in Section 033500 "Concrete Finishing."

B. Lumber Forms:

1. Applications: Edge forms and unexposed finish concrete.
2. Description:
 - a. Shiplapped or tongue and groove.
 - b. Surface boards on four sides.

3. Material: Standard grade, Douglas fir according to WCLIB Standard No. 17.
4. Width: 8 inches.

C. Preformed Steel Forms:

1. Description: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
2. Minimum Thickness: 16 gage.

D. Steel Forms: Description: Sheet steel, suitably reinforced.

E. Smooth Form Liners: Smooth, durable, grainless, and non-staining hardboard unless otherwise indicated on Drawings.

F. Framing, Studding, and Bracing: Stud or No. 3 structural light-framing grade.

2.4 FORMWORK ACCESSORIES

A. Form Ties:

1. Coil and Wire Ties: Provide ties manufactured so that after removal of projecting part, no metal remains within 1-1/2 inch of concrete face. The part of the tie to be removed shall be at least 1/2-in diameter or be provided with a plastic or wooden cone at least 1/2 inch 1/2-in diameter and 1-1/2 inch long. Provide cone washer type form ties in concrete exposed to view.
2. Flat Bar Ties for Panel Forms: Provide ties that have plastic or rubber inserts with a minimum depth of 1-1/2 inch and manufactured to permit patching of the tie hole.
3. Provide ties for liquid retaining structures and exterior below grade basement walls that have a steel waterstop tightly attached to each strut or that have a neoprene rubber washer on each strut.
4. Alternate form ties consisting of tapered through-bolts at least 1 inch in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of same minimum size may be used. Install in forms so that large end is, where applicable, on liquid or backfilled side of the wall. Clean, fill, and seal form tie hole with rubber plug installed from the liquid or backfilled side and non-shrink cement grout to provide watertight form tie holes. Make repairs needed to make watertight.
5. Alternate form ties specified in Paragraph above may be used when forms are to be set against previously placed or existing concrete walls. Use in conjunction with cast-in threaded inserts or drilled-in threaded anchors so that no metal remains within expansion joint upon removal of tapered through bolt. Conform to requirements specified in above Paragraph.

B. Spreaders:

1. Description: Standard, non-corrosive, metal-form clamp assembly of type acting as spreaders and leaving no metal within 1 inch of concrete face.
2. Wire ties, wood spreaders, or through bolts are not permitted.

C. Form Release Agent:

1. Description: Colorless form coating that will not stain concrete or absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.
2. Form Release Agent. Coat form surfaces in contact with concrete with an effective, non-staining, non-residual, water based, bond-breaking form coating, unless otherwise indicated or specified. Form release agent shall not impair the bond of paint, sealant, waterproofing, dampproofing, or other coatings.
3. For concrete surfaces which are to be painted, use forms with high density overlay or a similar material which does not require a form release agent unless Contractor can substantiate to satisfaction of the Engineer that form release agent will not remain on formed surface after it is stripped.

D. Bond Breaker:

1. Bond breakers for precast and tilt-up construction when cast against concrete shall be a non-staining, non-residual type, which will provide a positive bond prevention.
2. Acceptable Manufacturers: One of the following:
 - a. Dayton Superior Specialty Chemical Corporation: Sure-Lift (J-6).
 - b. Universal Form Clamp Co: Super Clean and Tilt.
 - c. Nox-Crete Products Group: Silcoseal Select.

E. Corners, Recesses for Joint Sealant, and Drip Edges:

1. Type: Fillet, Chamfer, wood strip.
2. Size: 1/2 inch round.
3. Lengths: Maximum possible.

F. Nails, Spikes, Lag Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and centers before proceeding with formwork.
- B. Verify that dimensions agree with Drawings and Shop Drawings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Earth Forms:

1. Trench earth forms neatly, accurately, and at least 2 inches wider than footing widths indicated on Drawings.
2. Trim sides and bottom of earth forms.

3. Construct wood edge strips at top of each side of trench to secure reinforcing and to prevent trench from sloughing.
4. Form sides of footings where earth sloughs.
5. Tamp earth forms firm and clear them of debris and loose material before depositing concrete.

B. Formwork:

1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
3. Camber forms where necessary to produce level finished soffits unless indicated otherwise on Drawings.
4. Positioning:
 - a. Carefully verify horizontal and vertical positions of forms.
 - b. Correct misaligned or misplaced forms before placing concrete.
5. Complete wedging and bracing before placing concrete.
6. Erect formwork, shoring, and bracing according to ACI 301, 318 and 347.
7. Obtain approval of Engineer before framing openings in structural members not indicated on Drawings.
8. Install fillet and chamfer strips for corners, recesses for sealant, and drip edges exposed corners of beams, columns, and walls.
9. Form Release Agent:
 - a. Apply according to manufacturer instructions.
 - b. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
 - c. Do not apply form release agent if concrete surfaces are indicated to receive special finishes or applied coverings that may be affected by agent.
 - d. Soak inside surfaces of untreated forms with clean water, and keep surfaces coated prior to placement of concrete.
 - e. Apply form coatings before placing reinforcing steel.
10. Leave forms in place for minimum number of days according to ACI 347 and as indicated in section 033000.
11. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and until the concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces.
12. Do not remove shores until concrete has attained at least 70 percent of its specified design strength and also sufficient to support safely its own weight and the construction live load on it.
13. Loosen forms carefully; do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

14. Stripping:

- a. Arrange and assemble formwork to permit dismantling and stripping.
- b. Do not damage concrete during stripping.
- c. Permit removal of remaining principal shores.

15. Be responsible for damage resulting from removal of forms and make repairs at no additional compensation. Leave in place forms and shoring for horizontal structural members in accordance with ACI 301 and ACI 347. Conform to requirements for form removal specified in Section 033000 "Cast-in-Place Concrete."

16. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged.

17. Discard damaged forms.

18. Reuse and Coating of Forms:

- a. Thoroughly clean forms and reapply form coating before each reuse.
- b. For exposed Work, do not reuse forms with damaged faces or edges.
- c. Apply form coating to forms according to manufacturer instructions.
- d. Do not coat forms for concrete indicated to receive "scored finish."

19. Do not patch formwork.

20. Form Cleaning:

- a. Clean forms as erection proceeds to remove foreign matter within forms.
- b. Clean formed cavities of debris prior to placing concrete.
- c. Flush with water or use compressed air to remove remaining foreign matter.
- d. Ensure that water and debris drain to exterior through cleanout ports.
- e. Cold Weather:

- 1) During cold weather, remove ice and snow from within forms.
- 2) Do not use de-icing salts.
- 3) Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure; use compressed air or other dry method to remove foreign matter.

C. Forms for Smooth Finish Concrete:

- 1. Use steel, plywood, or lined-board forms.
- 2. Use clean and smooth plywood and smooth sheet form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.
- 3. Install smooth sheet form lining with close-fitting square joints between separate sheets without springing into place.
- 4. Use full-sized sheets of smooth sheet form liners and plywood wherever possible.
- 5. Tape joints to prevent protrusions in concrete.
- 6. Apply forming and strip wood forms in a manner to protect corners and edges.
- 7. Level and continue horizontal joints.

D. Forms for Surfaces to Receive Membrane Waterproofing:

- 1. Use plywood or steel forms.
- 2. After erection of forms, tape form joints to prevent protrusions in concrete.

E. Framing, Studding, and Bracing:

1. Framing, Studding, and Bracing: Stud or No. 3 structural light-framing grade.
2. Maximum Spacing of Studs:
 - a. Boards: Maximum 16 inches o.c.
 - b. Plywood: 12 inches o.c.
3. Size framing, bracing, centering, and supporting members for sufficient strength to maintain shape and position under imposed loads from construction operations.
4. Construct beam soffits of material minimum 2 inches thick.
5. Distribute bracing loads over base area on which bracing is erected.
6. When placed on ground, protect against undermining, settlement, and accidental impact.

F. Form Anchors and Hangers:

1. Do not use anchors and hangers leaving exposed metal at concrete surface.
2. Symmetrically arrange hangers supporting forms from structural-steel members to minimize twisting or rotation of member.
3. Penetration of structural-steel members is not permitted.

G. Inserts, Embedded Parts, and Openings:

1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.
2. Do not embed wood or uncoated aluminum in concrete.
3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.
6. Install formed openings for items to be embedded in or passing through concrete Work.
7. Locate and set in place items required to be cast directly into concrete.
8. Install accessories straight, level, and plumb, and ensure that items are not disturbed during concrete placement.
9. Frame openings in concrete where indicated on Drawings.
10. Establish exact locations, sizes, and other conditions required for openings and attachment of Work specified under other Sections.
11. Coordinate Work to avoid cutting and patching of concrete after placement.
12. Temporary Openings:
 - a. Provide temporary ports or openings in formwork as required to facilitate cleaning
 - b. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
 - c. Locate openings at bottom of forms to allow flushing water to drain.
 - d. Remove chips, sawdust, and other debris.
 - e. Thoroughly blow out forms with compressed air just before concrete is placed and inspection.

- f. Clean forms and surfaces against which concrete is to be placed.
- g. Close temporary openings with tight-fitting panels, flush with inside face of forms, and neatly fitted such that joints will not be apparent in exposed concrete surfaces.

H. Form Ties:

- 1. Provide sufficient strength and quantity to prevent spreading of forms.
- 2. Place ties at least 1 inch away from edge of concrete.
- 3. Leave inner rods in concrete when forms are stripped.
- 4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally unless indicated otherwise on Drawings.

I. Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

J. Construction Joints:

- 1. Install surfaced pouring strip where construction joints intersect on exposed surfaces to provide straight line at joints.
- 2. Just prior to subsequent concrete placement, remove strip, and tighten forms to conceal shrinkage.
- 3. Appearance:
 - a. Show no overlapping of construction joints.
 - b. Construct joints to present same appearance as butted plywood joints.
- 4. Arrange joints in continuous line straight, true, and sharp.

K. Embedded Items:

- 1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.
- 2. Do not embed wood or uncoated aluminum in concrete.
- 3. Obtain installation and setting information for embedded items furnished under other Sections.
- 4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
- 5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.

L. Screeds:

- 1. Set screeds and establish levels for tops of and finish on concrete slabs.
- 2. Slope slabs to drain where required or as indicated on Drawings.
- 3. Before depositing concrete, remove debris from space to be occupied by concrete, thoroughly wet forms, and remove freestanding water.

M. Screed Supports:

- 1. For concrete over waterproof membranes and vapor retarder membranes, use cradle-, pad-, or base-type screed supports that will not puncture membrane.

2. Staking through membrane is not permitted.

N. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
2. Clean forms and surfaces against which concrete is to be placed.
3. Remove chips, sawdust, and other debris.
4. Thoroughly blow out forms with compressed air just before concrete is placed.

3.3 TOLERANCES

- A. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances according to ACI 117.
- B. Camber:
1. According to ACI 301.
- C. Formed Surface Including Mass Concrete, Pipe Encasement, Electrical Raceway Encasement and Other Similar Installations: No minimum requirements for surface irregularities and surface alignment. The overall dimensions of the concrete shall be plus or minus 1 inch from the intended surface indicated.
- D. Formed Surfaces to be Painted: Surface irregularities limited to 1/16 inch at any point. Variation in alignment not to exceed 1/16 inch per 4 feet. Do not allow maximum deviation of finish surface at any point to exceed 1/4 inch from intended surface indicated.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
- B. Inspection:
1. Inspect erected formwork, shoring, and bracing to ensure that Work complies with formwork design and that supports, fastenings, wedges, ties, and items are secure.
 2. Notify Engineer after placement of reinforcing steel in forms at least six working hours prior to proposed concrete placement.
 3. Schedule concrete placement to permit formwork inspection before placing concrete.
 4. Failure of forms to comply with specified requirements or to produce concrete complying with requirements specified shall be grounds for rejection of that portion of concrete work. Repair or replace rejected work as directed by the Engineer at no additional compensation. Make required repair or replacement subject to requirements of these Specifications and approval of the Engineer.

3.5 SCHEDULE

- A. Concrete Not Exposed to View: Site-fabricated plywood coated with form oil.

- B. Concrete Exposed to View: New and unused Plyform exterior grade plywood panels or steel forms.
- C. Supported Floor Slabs: wood forms or steel forms.

END OF SECTION 031000.00

SECTION 031500 - CONCRETE JOINTS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes construction of durable, watertight joints in concrete structures.
- B. Related Requirements:
 - 1. Section 031000 "Concrete Forming and Accessories" for formwork.
 - 2. Section 032000 "Concrete Reinforcing" for reinforcing.
 - 3. Section 033000 "Cast-In-Place Concrete" for cement, and related concrete products.
 - 4. Section 033600 "Grout" for grout related work.
 - 5. Section 030130.71 "Modifications to Existing Concrete".
 - 6. Section 055000 "Miscellaneous Metals for various metal fabrications.
 - 7. Section 079200 "Joint Sealants" for joint sealants and accessories.

1.3 ACTION SUBMITTALS

- A. Do not ask for manufacturer's specifications, material safety data sheets, installation instructions, and similar items that may conflict with specification requirements or needlessly involve Architect in Contractor's means and methods of construction.
- B. Plastic Waterstops: Product data including sample, catalogue cut, dimensions, technical data, storage requirements, splicing methods, conformity to CRD standards, details and samples of factory fabrications.
- C. Special Waterstops: Product data including location of use, sample, catalogue cut, technical data, storage requirements, splicing methods, installation instructions, and conformity to CRD, ASTM or FS standards, as applicable.
- D. Premolded Joint Fillers: Product data including location of use, sample, catalogue cut, technical data, storage requirements, and conformity to ASTM standards.
- E. Preformed Expansion Joint Material: Product data including location of use, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to ASTM standards.
- F. Bond Breaker: Product data including location of use, catalogue cut, technical data, storage requirements, and application instructions.

- G. Expansion Joint Dowels: Product data on the complete assembly including dowel material, sizes and dimensions, coatings, expansion dowel caps, installation instructions and conformity to ASTM standards.
- H. Sealant: Product data including location of use, catalogue cut, technical data, storage requirements, mixing and application instructions, and conformity to ASTM standards.
- I. Neoprene Bearing Pads: Product data including location of use, sample, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to AASHTO standards.

1.4 INFORMATIONAL SUBMITTALS

- A. System and Material Certificates:
 - 1. Certify that materials used within joint system are compatible with each other.
 - 2. Certify that sealant is made for use in continuous immersion in contact with wastewater.

1.5 QUALITY ASSURANCE

- A. Sealant Manufacturer's Field Representative Qualifications:
 - 1. Experience: Performed at least five projects of similar size and complexity within last five years. Be present at work site prior to mixing to instruct on mixing, application, and inspection procedures. Inspect finish of prepared surfaces prior to sealant application.
 - 2. Make at least one additional visit to site as the work progresses and report on each visit to Contractor and the Engineer. Advise whether the application is in accordance with this Section and manufacturer's printed installation instructions.
- B. Installer Qualifications: Fabricator of products.
- C. PRODUCTS

1.6 GENERAL REQUIREMENTS

- A. Use materials in a given joint that are compatible with one another. Coordinate selection of suppliers and products to provide compatibility. Do not use asphaltic bond breakers or asphaltic joint fillers in joints receiving sealant.
- B. Product Experience: Provide plastic waterstops, expansive waterstops, and adhesive waterstops products specifically manufactured for intended purpose and have five years' successfully experience in similar applications.

1.7 MATERIALS - SPECIAL WATERSTOPS

A. Expansive Waterstops for Construction Joints Where Indicated:

1. Type A - Preformed Bentonite and Butyl Rubber Based System:
 - a. Installation Adhesives: Use with expansive waterstops as recommended by waterstop manufacturer.
 - b. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) CETCO: Volclay Waterstop-RX101.
 - 2) Sika: 3/4-in by 1-in Swellstop.
 - 3) GCP Applied Technologies: Adcor ES.
2. Type B - Preformed Hydrophilic Rubber Strips:
 - a. Installation Adhesives: Use with expansive waterstops as recommended by waterstop manufacturer.
 - b. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) Sika: Hydrotite CJ-1020-2K.
 - 2) OCM: Adeka Ultraseal MC-2010MN.
 - 3) GCP Applied Technologies: Adcor ES.

1.8 MATERIALS - ACCESSORIES

A. Premolded Joint Filler - Structures: ASTM D 1752, Type III, self-expanding cork.

1. Thickness: 1 inch, unless otherwise indicated.

B. Bond Breaker:

1. Bond Breaker Tape: Adhesive-backed glazed butyl or polyethylene tape that adheres to premolded joint filler or concrete surface. Provide tape of same width as the joint.
2. Bond breaker for concrete other than where tape is indicated or specified: Either bond breaker tape or a non-staining type bond prevention coating.
 - a. Acceptable Coating Manufacturers: Provide products manufactured by one of the following or equal:
 - 1) Cresset Chemical Company: Crete-Lease Bond Breaker for Tilt-Up.
 - 2) Dayton Superior: Sure-Lift J-6 WB.
 - 3) Nox-Crete: Silco seal Select.
3. Bond Breaker for Expansion Joint Dowels: ASTM C 309, Type 2, Class A, water-based white pigmented curing compound.

C. Preformed Expansion Joint Material: Non-extrudable watertight strip material used to fill expansion joints between structures meeting following criteria:

1. Compressibility: Capable of being compressed at least 40 percent for 70 hours at 68 degrees F and subsequently recovering at least 20 percent of its original thickness in first 30 minutes after unloading.
 2. Basis-of-Design: Provide products as manufactured by Chase Construction Products, or equal:
 - a. Phyzite 380.
- D. Neoprene Bearing Pads: 50 durometer conforming to AASHTO Standard Specifications for Highway Bridges.
- E. Grout: Non-metallic, non-shrinking as specified in Section 033600 "Grouting."

1.9 MATERIALS - SEALANTS

A. Sealant:

1. Comply with ASTM C 920 for following conditions:
 - a. Sealant for Joints in Horizontal Surfaces: Type S or M, Grade P or NS, Class 25.
 - b. Sealant for Joints in Sloping and Vertical Surfaces: Type S or M, Grade NS, Class 25.
 - c. Sealant in Pedestrian and Vehicular Traffic Areas: Use T₁.
 - d. Sealant in Non-Traffic Areas: Type S or M, Grade P, Use NT.
2. Provide sealants made for use in continuous immersion in contact with wastewater. Provide gray colored sealants unless otherwise indicated, specified, or approved.

PART 2 - EXECUTION

2.1 INSTALLATION - WATERSTOPS, GENERAL

- A. Install waterstops for joints indicated and according to manufacturer's published installation instructions and approved submittals.
- B. Include waterstops continuous around corners and intersections to provide a continuous seal.
- C. Provide a minimum number of connections or splices. Replace connections or splices that do not meet specified requirements at no additional cost to Owner.
- D. Secure waterstops in joints before concrete is placed.
- E. Protect waterstops from damage in intervals between placing waterstops and subsequent placing of concrete. Replace damaged or punctured waterstops at no additional cost to Owner.
- F. Provide waterstops free from form release agent, bond breaker, dirt, concrete splatter, ice, mortar, paint, or other deleterious material that could reduce or destroy bond between waterstop and adjacent concrete.

2.2 INSTALLATION - SPECIAL WATERSTOPS

- A. Install special waterstops at joints only where specifically indicated on Drawings. Provide waterstops continuous around corners and intersections to provide a continuous seal.
- B. Use waterstops of maximum practicable length to provide a minimum number of joints, connections, or splices. Make joints, connections, and splices conforming to manufacturer's recommended.
- C. Terminate waterstops 2 inches below exposed top of walls.
- D. Expansive Type and Preformed Adhesive Waterstops:
 - 1. Clean and prepare joint surfaces, install primers or adhesives, and install Type A expansive and Type B expansive waterstops on dry surfaces in accordance with manufacturer's instructions, including concrete cure, temperature conditions, and splices.
 - 2. Use mechanical fasteners to secure Type A expansive, Type B expansive waterstops to previously placed vertical and overhead concrete surfaces and other locations, as recommended by manufacturer. Protect installed waterstops from moisture and keep dry until subsequent placement of concrete.

2.3 INSTALLATION - CONSTRUCTION JOINTS

- A. Make construction joints only at locations indicated or as approved by the Engineer. Submit additional or relocation of construction joints proposed by Contractor to the Engineer for written approval. Do not eliminate construction joints.
- B. Locate additional or relocated joints where they least impair member strength. In general, locate joints within middle third of spans of slabs, beams, and girders.
 - 1. If a beam intersects a girder at joint, offset joint a distance equal to twice the width of member being connected.
 - 2. Locate joints in walls and columns at underside of floors, slabs, beams, or girders and at tops of footings or floor slabs.
 - 3. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.
- C. Unless otherwise indicated, provide joints perpendicular to main reinforcement. Continue reinforcing steel through joint as indicated.
- D. Provide waterstops in wall and slab construction joints in liquid retaining structures and at other locations indicated.
- E. Roughened Construction Joints:
 - 1. At construction joints and at concrete joints indicated, uniformly roughen concrete surface with chipping tools to expose a fresh face 1/4 inch of a full amplitude, distance between high and low points and side to side.

2. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding.
3. At least two hours before and again shortly before new concrete is deposited, saturate joints with water.
4. After glistening water disappears, coat joints with neat cement slurry mixed to consistency of very heavy paste. Apply a coating to surfaces at least 1/8 inch, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before neat cement dries.

2.4 INSTALLATION - PARTIAL CONTRACTION JOINTS

- A. Make partial contraction joints at locations indicated. Do not eliminate or relocate partial contraction joints.
- B. Provide waterstops, sealant grooves, and sealants in wall and slab partial contraction joints in liquid retaining structures and at other locations indicated.
- C. Extend every other bar of reinforcing steel through partial contraction joints or as indicated on Drawings. Coat concrete surface with a bond breaker prior to placing new concrete against it as indicated on Drawings.
 1. Do not coat reinforcement or waterstops with bond breaker. Mask waterstops and reinforcing passing through joint to prevent bond breaker from running or dripping on to them. Remove masking prior to concrete placement.

2.5 INSTALLATION - SEALANTS

- A. Install sealants in clean dry recesses free of frost, oil, grease, form release agent, loose material, laitance, dirt, dust, and other deleterious materials that will impair bond.
- B. Apply sealant conforming to manufacturer's recommendations including concrete cure, temperature, moisture, mixing, primer, primer cure time, joint and recess preparation, tooling, and curing.
- C. Apply masking tape to each side of joint prior to sealant installation. Remove masking tape afterwards, along with any spillage to leave a sealant installation with neat straight edges.

2.6 INSTALLATION - PREFORMED EXPANSION JOINT MATERIAL

- A. Install preformed expansion joint material in conformance with manufacturer's recommendations; including surface preparation, adhesive installation, heat welding, and set time.

2.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect system components verifying that installation conforms to manufacturer's installation instructions.,
 - 1. Prepare test and inspection reports.

2.8 CLEANING AND PROTECTION

- A. Clean adjacent surfaces removing excess spills.
- B. Protect installed products until subsequent work is installed. For exposed materials, protect from damage until Substantial Completion.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 031500

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Reinforcing bars.
 - 2. Welded wire fabric.
 - 3. Reinforcement accessories.

- B. Related Requirements:

- 1. Section 031000 - Concrete Forming and Accessories: Form materials, and accessories required to form cast-in-place concrete.
 - 2. Section 033000 - Cast-in-Place Concrete: Cast-in-place concrete.
 - 3. Section 042200 - Concrete Masonry Units: Reinforcement for concrete masonry units.

1.3 COORDINATION

- A. Coordinate Work of this Section with placement of formwork, formed openings, masonry dowels, and other Work.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.

- B. Shop Drawings:

- 1. Indicate bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel and welded wire fabric.
 - 2. Indicate bending and cutting schedules.
 - 3. Indicate supporting and spacing devices.
 - 4. Placement Drawings:
 - a. Walls: Show elevations from outside, looking towards the structure, at a minimum scale of 1/4 inch to one foot.
 - b. Slabs: Show top and bottom reinforcement on separate plan views, as needed for clarity.

- c. Beams and Columns: Show schedules with sections, elevations, and stirrup/tie spacing.
 - d. Show additional reinforcement around openings, at corners and at other locations indicated, diagrams of bent bars, arrangements and assemblies, all as required for the fabrication and placement of concrete reinforcement.
 - e. Reference bars to same identification marks shown on bar bending details. Identify bars to have special coatings or to be of special steel or special yield strength.
- C. Samples: Two samples of each type of mechanical reinforcing steel coupling system.

1.5 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Submit certified copies of mill test report of reinforcement materials analysis.

1.6 QUALITY ASSURANCE

- A. Perform Work according to CRSI 10-MSP, ACI 301 and ACI 318.
- B. Prepare Shop Drawings according to ACI SP-66.
- C. Maintain one copy of each standard affecting Work of this Section on Site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Ship and store reinforcement with bars of same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing same "mark" designations as those shown on submitted placement drawings. Indicate that reinforcing is weldable on tags for ASTM A 706 reinforcing and for ASTM A 615 reinforcing meeting specified requirements in PART 2.
- D. Store materials according to manufacturer instructions.
- E. Protection:
 - 1. Protect materials from moisture by storing off ground, in clean, and dry location.
 - 2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel:

1. Comply with ASTM A 615.
2. Yield Strength: 60 ksi
3. Billet Bars: Deformed.
4. Finish: Uncoated.

B. Welded Plain Wire Fabric:

1. Comply with ASTM A 1064.
2. Configuration: Flat sheets.
3. Finish: Uncoated.

2.2 FABRICATION

- A. Fabricate concrete reinforcement according to CRSI 10-MSP and ACI 318.
- B. Form standard hooks for 180-degree bends, 90-degree bends, stirrups and tie hooks as indicated.
- C. Form reinforcement bends with minimum diameters according to ACI 318.
- D. Bend bars cold. Do not straighten or rebend bars.
- E. Bend bars around a revolving collar having a diameter not less than that recommended by the CRSI or ACI 318.
- F. Saw cut bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded. Terminate saw cut ends in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.
- G. Fabricate column reinforcement with offset bends at reinforcement splices.
- H. Form ties and stirrups as indicated

2.3 ACCESSORY MATERIALS

A. Tie Wire:

1. Minimum 16 gage, annealed type. Use black wire to tie uncoated reinforcing.

B. Reinforcing Steel Accessories:

1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.
2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.
3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with CRSI 10-MSP for surface condition, bending, spacing and tolerances of placement for reinforcement. Provide the amount of reinforcing indicated at the spacing and clearances indicated on the Drawings.
- B. Coat uncoated reinforcement which will be exposed for more than 60 days after placement with a heavy coat of neat cement slurry.
- C. Do not weld reinforcing steel bars either during fabrication or erection unless prior written approval has been obtained from the Engineer. Remove immediately all bars that have been welded, including tack welds, without such approval. Comply with AWS D1.4 when welding of reinforcement is indicated, specified, or approved.
- D. Reinforcing steel interfering with the location of other reinforcing steel, piping, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Obtain the approval of the Engineer if greater displacement of bars to avoid interference is needed. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.
- E. Place, support, and secure reinforcement against displacement. Secure dowels in place before placing concrete.
- F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- G. Do not deviate from required position beyond specified tolerance.
- H. Do not field bend reinforcing unless indicated or specifically authorized in writing by the Engineer. Cold-bend bars indicated or authorized to be field bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. Replace, repair by cutting out damaged bars and splicing new bars using exothermic welding type reinforcing splicing devices, or otherwise repair damaged reinforcing bars as directed by the Engineer at no additional cost to Owner. Do not bend reinforcement after it is embedded in concrete unless indicated.

- I. Do not displace or damage vapor retarder.
- J. Chairs, Bolsters, Bar Supports, and Spacers:
 - 1. Size and Shape: To support reinforcement and prevent displacement of reinforcing during concrete placement conditions.
 - 2. Furnish load-bearing pad on bottom to prevent vapor retarder puncture.
 - 3. Use precast concrete blocks where reinforcing steel is to be supported over soil.
 - 4. Use stainless-steel protected bar supports and stainless-steel waterstops in water containment structures subject to ozone disinfection process (including slabs over these areas). Use plastic protected bar supports in all other work. In some instances, however, problems have been encountered when finishing walls with plastic protected supports due to melting of the plastic from high ambient or surface temperatures.
 - 5. Use plastic protected bar supports or steel supports with plastic tips where reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use stainless-steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.
 - 6. Provide #5 minimum size support bars. Do not reposition upper bars in a bar mat for use as support bars.
 - 7. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.
- K. Spacing:
 - 1. Space reinforcement bars with minimum clear spacing according to ACI 350.
 - 2. If bars are indicated in multiple layers, place upper bars directly above lower bars.
- L. Determine clear concrete cover based on exposure to the environment. Provide the following minimum clear concrete cover over reinforcement, unless indicated otherwise:
 - 1. Concrete cast against and permanently exposed to earth: 3 inches.
 - 2. Concrete exposed to soil, water, sewage, sludge and/or weather:
 - a. Slabs (top and bottom cover), walls: 2 inches.
 - b. Beams and columns (ties, spirals and stirrups): 2 inches.
 - 3. Concrete not exposed to soil, water, sewage, sludge and/or weather:
 - a. Slabs (top and bottom cover), walls, joists, shells and folded plate members: 1 inch.
 - b. Beams and columns (ties, spirals and stirrups): 1-1/2 inches.
- M. Splicing:
 - 1. Tension Members: Avoid splicing of reinforcing steel in concrete elements indicated as "tension members." However, if splices are required for constructability, splices in the reinforcement subject to direct tension shall be butted and joined with complete penetration welds to develop, in tension, at least 125 percent of the specified yield strength of the

- bar. Offset splices in adjacent bars the distance of a Class B splice or 30 inches, whichever is greater.
 - 2. Welded Wire Fabric: Provide lap splices in accordance with the requirements of ACI 318 but not less than 12 inches. Tie the spliced fabrics together with wire ties spaced not more than 24 inches on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
 - 3. Reinforcing Splicing Devices: Use only where indicated. Offset splices in adjacent bars by at least 30 bar diameters. Use only for special splice and dowel conditions indicated or approved by the Engineer.
 - 4. After installation of mechanical reinforcing steel coupling system, on reinforcement, repair coating damage in accordance with applicable ASTM standard. Coat all parts of mechanical connectors used on coated bars including steel splice sleeves, bolts, and nuts with same material used for repair of damaged coating.
 - 5. Locate reinforcement splices at point of minimum stress, unless indicated otherwise.
 - 6. Obtain approval of splice locations from Engineer.
- N. Place dowels for concrete masonry units in accordance with approved placement drawings.

3.2 TOLERANCES

- A. Section 014000 - Quality Requirements: Requirements for tolerances.
- B. Install reinforcement within following tolerances for flexural members, walls, and compression members:
 - 1. Reinforcement Depth Greater Than 8 Inches:
 - a. Depth Tolerance: Plus or Minus 3/8 inch.
 - b. Concrete Cover Tolerance: Minus 3/8 inch.
 - 2. Reinforcement Depth Less Than or Equal to 8 Inches:
 - a. Depth Tolerance: Plus or Minus 1/2 inch.
 - b. Concrete Cover Tolerance: Minus 1/2 inch.

3.3 FIELD QUALITY CONTROL

- A. Inspection by Engineer: When reinforcing is complete and ready for inspection, notify Engineer at least six working hours prior to proposed concrete placement.
- B. Do not cover reinforcing steel with concrete until reinforcement, including the size, spacing and position has been inspected by the Engineer and the Engineer's release to proceed with concreting has been obtained. Keep forms open until the Engineer has completed inspection of the reinforcement.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Cast-in-Place Concrete for various items indicated in Contract Documents.
- B. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the Contractor. Provide field sampling, testing, inspection and related laboratory tests.
- C. Related Requirements:
 - 1. Section 031000 - Concrete Forming and Accessories: Formwork and accessories.
 - 2. Section 032000 - Concrete Reinforcing: Requirements for reinforcing steel and supports.
 - 3. Section 032500 - Concrete Joint and Joint Accessories.
 - 4. Various Sections in Divisions 21 through 23: Mechanical items for casting into concrete.
 - 5. Various Sections in Divisions 26 through 28: Electrical items for casting into concrete.

1.3 COORDINATION

- A. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

1.4 ACTION SUBMITTALS

- A. Submit, in accordance with Section 013300, product data for:
 - 1. Sources of cement, fly ash or ground granulated blast furnace slag, aggregates, and batched concrete. Indicate name and address of mill, quarry, or plant.
 - 2. Air entrainment admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
 - 4. Cold weather and hot weather concreting plans demonstrating how concrete will meet the requirements of this Section including but not limited to concrete mixes, placement, curing and protection.

- B. High-range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.
- C. Samples: Fine and coarse aggregates, if requested for examination by the Engineer.

1.5 INFORMATIONAL SUBMITTALS

A. Test Reports:

1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.
2. Cement and fly ash or ground granulated blast furnace slag: Conformance to ASTM standards, including chemical analysis and physical tests.
3. Concrete Mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement [and type and manufacturer of fly ash or ground granulated blast furnace slag]. Provide either subparagraph a. or b., below, for each mix proposed.
 - a. Standard deviation data for each proposed concrete mix based on statistical records. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:
 - 1) Date of sampling and name of testing laboratory.
 - 2) Name of concrete batch plant.
 - 3) Water cementitious ratio.
 - 4) Slump of batch.
 - 5) Air content of batch.
 - 6) Compressive strengths of all cylinders tested at that age in that batch.
 - 7) If available, temperature and unit weight of batch.
 - 8) Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.
 - b. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7, 14, and 28 days for laboratory concrete mix designs.

B. Certifications:

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certify that Contractor is not associated with independent testing laboratory proposed for use by Contractor nor does Contractor or its officers have a beneficial interest in the laboratory.
3. Certificate of conformance for concrete production facilities from the NRMCA.

C. Qualifications:

1. Independent Testing Laboratory:

- a. Name and address
- b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.
- c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
- d. Names and qualifications of the supervising laboratory technicians.
- e. Statement of conformance provided by evaluation authority defined in ASTM C 1077. Provide report prepared by evaluation authority when requested by the Engineer.
- f. Submit as required above for other organizations that will provide external technical services.

1.6 CLOSEOUT SUBMITTALS

- A. Section 017300 - Execution: Requirements for submittals.
- B. Project Record Documents: Record actual locations of embedded utilities and components concealed from view in finished construction.

1.7 QUALITY ASSURANCE

- A. Comply with ACI 318 and ACI 350 and other stated specifications, codes and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.
- B. Independent Testing Laboratory: Meet requirements of ASTM E 329 and ASTM C 1077. Do not use laboratories affiliated and having a beneficial interest with Contractor or its officers.
- C. Provide concrete uniform in color and appearance.
- D. Preconstruction Meeting: At least 10 working days before first concrete placement, hold a meeting to review concrete placement requirements, waterstop placement, jointing, concrete curing, hot and cold weather concreting, and finishing. Notify all parties involved, including the Engineer, of the meeting at least 10 working days prior to its scheduled date. Prepare an agenda for the meeting. Take meeting minutes and distribute to meeting attendees.
- E. If during work progress, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. Make ordered changes without additional compensation.
- F. If during work progress, materials from the sources originally accepted change in characteristics, make new acceptance tests of materials and establish new concrete mixes with assistance of an independent testing laboratory, without additional compensation.

- G. Provide field testing and inspection services and related laboratory tests. Perform testing methods conforming to latest applicable ASTM methods. Test following items to verify conformity with this Section:
 - 1. Concrete Placements: Compressive strength (cylinders), temperature, slump, and air content.
 - 2. Other materials that may require field testing.
- H. Concrete Placement: Compressive strength (cylinders), temperature, slump, and air content.
- I. Provide laboratory tests of samples, constituents, and as-placed concrete. Materials incorporated in the work shall conform to accepted samples.
- J. Perform Work according to ACI 350).
- K. Comply with ACI 305R when placing concrete during hot weather.
- L. Comply with ACI 306.1 when placing concrete during cold weather.
- M. Acquire cement and aggregate from one source for Work.
- N. Maintain one copy of each standard affecting Work of this Section on Site.

1.8 AMBIENT CONDITIONS

- A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.
- B. Maintain concrete temperature after installation at minimum 50 degrees F for minimum seven days.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials shall comply with this Section and any applicable State or local requirements.
- B. Cement: Domestic portland cement conforming to ASTM C 150. Do not use air entraining cements. Cement brand must be approved by the Engineer and one brand shall be used throughout the work.
 - 1. Comply with ASTM C150, Type II - Moderate Sulfate Resistant.
 - 2. Type: Portland.
- C. Aggregates:
 - 1. Fine Aggregate: Washed inert natural sand conforming to ASTM C 33.
 - 2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C 33. Grading requirements are listed in ASTM C 33, Table 3 for the specified coarse

aggregate size number listed in Table 1. Limits of deleterious substances and physical property requirements are listed in ASTM C 33, Table 4 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.

3. Fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C 1260 and using project proposed cement. If aggregates proposed do not meet this requirement, then satisfy either subparagraph a. or b. below.
 - a. Total equivalent alkali content of the cement: Do not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C 150.
 - b. Fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C 1260 and using the cement and fly ash or ground granulated blast furnace slag proposed for the project. Proportions of cement-fly ash mix or cement-ground granulated blast furnace slag mix shall be the same as those proposed for the project.
- D. Do not use lightweight aggregate for water retaining structures.
- E. Water:
 1. Comply with ACI 350.
 2. Potable, without deleterious amounts of chloride ions.
- F. Admixtures: Use admixtures free of chlorides and alkalis, except for those attributable to drinking water. Provide admixtures from same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with concrete mix including other admixtures. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixtures when so approved.
 1. Air Entrainment: Comply with ASTM C260.
 2. Chemical:
 - a. Comply with ASTM C 494.
 - b. Type A - Water Reducing.
 - c. Type F - Water Reducing, High Range
- G. Supplementary Cementitious Materials:
 1. Fly Ash: Class F fly ash complying with ASTM C 618, including the requirements of Table 1 but with the Loss on Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.
 2. Ground Granulated Blast Furnace Slag: Grade 100 or Grade 120 ground granulated blast furnace slag complying with ASTM C 989. Provide ground granulated blast furnace slag from a single source and uniform in color. Mill test reports submitted must be within 6 months of submittal date.

2.2 CONCRETE MIX

- A. Engage an independent testing laboratory to establish concrete mixes and perform sampling and laboratory testing of products and materials.
- B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce placeable, durable concrete conforming to these specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.
- C. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.
 - 1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents in accordance with ACI 350 and based on the modification factors for standard deviation tests contained in ACI 350.
 - 2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and 7, 14 and 28-day compressive strengths of concrete made using the proposed materials. Determine curves by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. Cementitious content of the concrete mixes to be used, as determined from the curve, shall correspond to the required average compressive strength in Table 5.3.2.2 of ACI 318. Resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 1.
- D. Test fly ash or ground granulated blast furnace slag and concrete mixture to provide test data confirming that materials in combination with the cement meet strength requirements and are compatible with other concrete additives.
- E. Test aggregates for potential alkali reactivity in accordance with ASTM C 1260. If initial testing indicates aggregates are not potentially reactive repeat test at 3 month intervals.
- F. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with compression strength requirements in conformity with the provisions of ACI 318.
- G. Entrained Air: Measure by ASTM C 231 as shown in Table 1.
 - 1. If proposed air entrainment admixture requires testing methods other than ASTM C 231 to accurately determine air content, make special note of this requirement in admixture submittal specified under Paragraph 1.4, A.
- H. Concrete Slump: Measure by ASTM C 143 as shown in Table 1. If a high-range water-reducing admixture (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 inches to 10 inches.

- I. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

J.

TABLE 1

Class	Design Strength 1	Cement 2	Fine Aggregate 3	Coarse Aggregate 3	Cementitious Content 4
A	2500	Type II	Sand	57 (9)	440
E1	4500	Type II	Sand	467	560
E2	4500	Type II	Sand	57	580
E3	4500	Type II	Sand	67	610

Class	W/C Ratio 5	SCM 6	AE Range 7	WR 8	HRWR 10	Slump Range Inches
A	0.62 max.	Yes	3.5 to 5	Yes	No	1-4
E1	0.42 max.	Yes	3.5 to 5	Yes	No	3-5
E2	0.42 max.	Yes	3.5 to 5	Yes	No	3-5
E3	0.42 max.	Yes	3.5 to 5	Yes	No	3-5

TABLE NOTES:

- Minimum compressive strength in psi at 28 days.
- ASTM designation in ASTM C 150.
- Size Number in ASTM C 33.
- Minimum cementitious content in lbs per cubic yard where fly ash or ground granulated blast furnace slag is used cementitious content is defined as cement content plus fly ash or ground granulated blast furnace slag content.
- W/C is Maximum Water Cementitious ratio by weight.
- Supplementary Cementitious Material (SCM) fly ash content in the range of 20-25 percent of the total cement content plus fly ash content, by weight. If ground granulated blast furnace slag is used in lieu of fly ash, the content of ground granulated blast furnace slag shall be in the range of 25-45 percent of the total cement plus ground granulated blast furnace slag content, by weight.
- AE is percent air entrainment.
- WR is water reducing admixture.
- Except as specified in Section 260543 for concrete electrical raceway encasement.
- HRWR is high-range water-reducing admixture.

K. Admixtures:

- Include admixture types approved by Engineer and their quantities in concrete mix designs.
- Cold Weather:
 - ASTM C 494 Type E admixture may be used in cold weather, if approved by the Engineer.
 - Use of admixtures will not relax cold-weather placement requirements.

3. Hot Weather:
 - a. ASTM C 494 Type D admixture may be used in hot weather, if approved by the Engineer.
 - b. Use of admixtures will not relax hot-weather placement requirements.
 4. Do not use calcium chloride or admixtures containing calcium chloride.
 5. Add air entrainment admixture to all concrete.
 6. Add water reducing admixture to all concrete.
- L. Ready-Mixed Concrete: Mix and deliver concrete according to ASTM C 94.

PART 3 - EXECUTION

3.1 MEASURING MATERIALS

- A. Provide concrete composed of portland cement, fly ash or ground granulated blast furnace slag, fine aggregate, coarse aggregate, water and admixtures as specified and produced by a plant complying with ACI 318 and ASTM C 94. Batch all constituents, including admixtures, at the plant. High-range water reducing admixtures may be added in the field.
- B. Measure materials for batching concrete by weighing in conformity with and within tolerances given in ASTM C 94 except as otherwise specified. Use scales last certified by the local Sealer of Weights and Measures within one year of use.
- C. Weigh cement and fly ash or ground granulated blast furnace slag in individual weigh batchers that are separate and distinct from weigh batchers used for other materials. When cement and fly ash or ground granulated blast furnace slag are weighed in a cumulative weigh batcher, the cement shall be weighed first.
- D. Measure the amount of free water in fine aggregates within 0.5 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record number of gallons of water as-batched on printed batch tickets.
- E. Dispense admixtures either manually using calibrated containers or measuring tanks or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
 1. Charge air entrainment and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
 2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTING

- A. Provide ready-mixed concrete produced by equipment complying with ACI 318 and ASTM C 94 and produced by a plant certified by the NRMCA. Do not hand-mix. Use truck mixers carrying a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.

- B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.
- C. Keep water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Engineer. Incorporate water directed to be added by additional mixing of at least 50 revolutions at mixing speed after the addition of all water. Meter all added water and show the amount of water added on each delivery ticket.
- D. Comply with ACI 318 and ASTM C 94 for central plant and rolling stock equipment and methods.
- E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20 feet long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.
- F. Do not retemper (mix with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened.
- G. Handle concrete from mixer to placement providing concrete of specified quality in the placement area and not exceeding the maximum time interval specified in Paragraph 3.2 I.4. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms. Remix for a minimum of 5 minutes prior to discharge or testing.
- H. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash or ground granulated blast furnace slag, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.
- I. Temperature and Mixing Time Control:
 - 1. In cold weather (see Paragraph 3.8, C) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.
 - 2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
 - 3. In hot weather (see Paragraph 3.8, D), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.
 - 4. Maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the values shown in the following Table 2:

TABLE 2

AIR OR CONCRETE TEMPERATURE
(WHICHEVER IS HIGHER)

MAXIMUM
TIME

(27 Degree C) 80 Degree F to 90 Degree F (32 Degree C)	45 minutes
(21 Degree C) 70 Degree F to 79 Degree F (26 Degree C)	60 minutes
(5 Degree C) 40 Degree F to 69 Degree F (20 Degree C)	90 minutes

5. If an approved high-range water-reducing admixture (plasticizer) is used to produce plasticized concrete, the maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed 90 minutes.

3.3 EXAMINATION

- A. Section 017300 - Execution: Requirements for installation examination.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify that anchors, seats, plates, reinforcement, piping, electrical conduits and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.
- D. At all times batch, mix, transport, place, and cure concrete to the inspection of the Engineer. Advise the Engineer of readiness to proceed at least 24 hours prior to each concrete placement. The Engineer will inspect the preparations for concreting, including preparation of previously placed concrete, reinforcing and alignment, cleanliness, and tightness of formwork. Do not place concrete without the inspection and acceptance of the Engineer.

3.4 EMBEDDED ITEMS

- A. Secure to forms as required or set for embedment as required, miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.
- B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.
- C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.
- D. Do not embed piping in concrete unless indicated on Drawings.
- E. Do not embed electrical conduits in concrete unless indicated on Drawings.

- F. Fabricate piping and conduit such that cutting, bending, or relocation of reinforcing steel is not required. Satisfy the following for pipes and conduits embedded within a slab or wall (other than those merely passing through), unless otherwise indicated on Drawings or approved:
 - 1. Maximum outside dimension of pipe or conduit: Be not greater than one third the overall thickness of slab or wall.
 - 2. Spacing of pipes or conduits: Be greater than or equal to three diameters or widths on center.
- G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.
- H. Ensure specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.
- I. Position embedded anchor bolts using templates.
- J. Correct embedded items not installed in the location or alignment needed or displaced by concrete placement without additional compensation.

3.5 PREPARATION

- A. Section 017300 - Execution: Requirements for installation preparation.
- B. Previously Placed Concrete:
 - 1. Prepare joints as specified in Section 032500 - Concrete Joints and Accessories.
- C. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- D. Remove water from areas receiving concrete before concrete is placed.

3.6 CONCRETE APPEARANCE

- A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Reject remixed concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Make, at no additional cost to the Owner, changes in the concrete mix design for future deliveries only by adjusting one or more of the following if the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finish ability are observed:
 - 1. Gradation of aggregate.
 - 2. Proportion of fine and coarse aggregate.
 - 3. Percentage of entrained air, within the allowable limits.
- B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified in Section 033500.

3.7 INSTALLATION

A. Placing Concrete:

1. Place concrete according to ACI 301 318 and 350.
2. Notify testing laboratory and Engineer minimum 24 hours prior to commencement of operations.
3. Ensure that reinforcement, inserts, embedded parts, formed expansion and contraction joints are not disturbed during concrete placement.
4. Install vapor retarder under interior slabs on grade according to ASTM E 1643.
5. Verify that formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement who can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Do not place concrete on frozen subgrade, snow, or ice.
6. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Place concrete continuously at a rate that allows the concrete previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
7. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, determine slump at point of truck discharge and determine air content at point of placement.
8. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval has been obtained.
9. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained design strength.
10. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar against the form. Prevent the formation of surface voids.
11. Slabs:
 - a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edgeform, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.
 - b. Avoid delays in placement. If there is a delay in placement, spade and consolidate concrete placed after the delay at the edge of previously placed concrete to avoid cold joints. Bring concrete to correct level and strike off with a straightedge. Use bullfloats or darbies to smooth the surface, leaving it free of humps or hollows.
 - c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep top surface of the wall moist to prevent cold joints.

12. Formed Concrete:

- a. Place concrete in forms using tremie tubes taking care to prevent segregation. Maintain bottom of tremie tubes near the surface of concrete already placed. Do not permit concrete to drop freely more than 4 feet. Place concrete for walls in 12 inch to 24 inch lifts, keeping the surface horizontal. If a high-range water-reducing admixture is used do not permit concrete to drop freely more than 15 feet; maximum lift thickness not to exceed 7 feet.
13. Bollards: Conform to requirements specified above for formed concrete and completely fill pipe with concrete as indicated.
14. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.

B. Compacting:

1. Consolidate concrete by vibration and puddling, spading, rodding, or forking so that concrete is completely worked around reinforcement, embedded items and openings and into corners of forms. Continuously perform puddling, spading, rodding, and forking along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
2. Compact concrete with mechanical vibrators. Do not order concrete until vibrators (including standby units in working order) are on the job.
3. Use mechanical vibrators having a minimum frequency of 8000 vibrations per minute. Insert vibrators and withdraw at points from 18 inches to 30 inches apart. Vibrate sufficiently at each insertion to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep standby vibrators on the site during concrete placing operations.
4. Concrete Slabs: Vibrate concrete slabs less than 8 inch thick by vibrating screeds. Vibrate concrete slabs 8 inches and thicker by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.
5. Walls and Columns: Use internal vibrators rather than form vibrators, unless otherwise approved by the Engineer. General: for each vibrator needed to level the batch at the point of discharge, use one or more additional vibrators to densify, homogenize, and perfect the surface. Insert vibrators vertically at regular intervals, through fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Use vibrators to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:
 - a. Frequency of vibrator returns to normal.
 - b. Surface appears liquefied, flattened and glistening.
 - c. Trapped air ceases to rise.
 - d. Coarse aggregate has blended into surface, but has not disappeared.

3.8 PROTECTION

- A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

- B. Protect finished surfaces and slabs whenever ambient conditions of humidity, temperature, sunlight and wind may result in the rapid evaporation of water from the concrete, to prevent checking and crazing, until the beginning of curing.
- C. Cold Weather Concreting:
 - 1. For this Specification, 'cold weather' is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of highest and lowest temperature during the period from midnight to midnight.
 - 2. Batch, deliver, place, cure, and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.
 - 3. Review cold weather concreting plan at preconstruction meeting. Include methods and procedures for use during cold weather including the production, transportation, placement, protection, curing, and temperature monitoring of concrete and procedures to be implemented upon abrupt changes in weather conditions or equipment failures.
 - 4. Maintain minimum temperature of concrete immediately after placement and during the protection period as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 3

Minimum Concrete
Temperatures For
Section Dimensions

Minimum Concrete	<u>< 12 inches</u>	<u>12 - 36 inches</u>
Temperature:	55 degrees F	50 degrees F

- 5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.
 - a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete, where 7 days at an average 50 degrees F equals 350 degree-days.
 - b. To calculate the weighted average daily air temperature, sum hourly measurements of air temperature in the shade at concrete surface taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
- 6. Do not use salt, manure or other chemicals for protection.
- 7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated and air-dry concrete for at least 3 days prior to first exposure to freezing temperatures.
- 8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

D. Hot Weather Concreting:

1. For this Specification, 'hot weather' is defined as any combination of high air temperatures, low relative humidity, and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour.
2. Batch, deliver, place, cure, and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.
 - a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.
 - b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.2 N.4. Provide vibration immediately after placement.
 - c. The Engineer may direct the Contractor to immediately cover concrete with sheet curing material.
3. Review hot weather concreting plan at preconstruction meeting. Include methods and procedures for use during hot weather, including production, placement, and curing.

3.9 REMOVAL OF FORMS

- A. Do not remove forms before concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing, whichever is longer.

TABLE 4

Forms for	Degree Days
Beams and slabs	500
Walls and vertical surfaces	100

(See definition of degree-days in Paragraph 3.8C).

- B. Do not remove shores until concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and construction live loads.
- C. In cold weather when temperature of concrete exceeds ambient air temperature by 20 degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

3.10 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
- B. Section 017300 - Execution: Requirements for testing, adjusting, and balancing.

- C. Perform inspection and testing according to ACI 318 and ACI 350.
- D. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.
- E. Submit proposed mix design of each class of concrete to testing firm for review and approval prior to commencement of Work.
- F. Concrete Inspections:
 - 1. Continuous Placement Inspection: Inspect for proper installation procedures.
 - 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
- G. Strength Test Samples:
 - 1. Sampling Procedures: Comply with ASTM C 172.
 - 2. Cylinder Molding and Curing Procedures:
 - a. Comply with ASTM C 31.
 - b. Cylinder Specimens: Standard cured.
 - 3. Sample concrete and make one set of five cylinders for every 100 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area for slabs and walls. Form specimens in 6 inch diameter by 12 inch long non-absorbent cylindrical molds.
 - 4. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five randomly selected batches, or from every batch, if less than five batches are used.
 - 5. Make one additional cylinder during cold weather concreting and field cure.
- H. Field Testing:
 - 1. Slump Test Method: Comply with ASTM C 143.
 - 2. Air Content Test Method: Comply with ASTM C 173C 231.
 - 3. Temperature Test Method: Comply with ASTM C 1064.
 - 4. Compressive Strength Concrete:
 - a. Measure slump and temperature for each sample. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.
 - b. Measure air content in air-entrained concrete for each sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C 231 or by the volumetric method complying with ASTM C 173. If aggregates with high absorptions are used, use the latter test method. When concrete is pumped, air content will be determined at point of placement.
- I. Cooperate in the making of tests by allowing free access to the work for the selection of samples. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the testing lab. Protect the specimens against injury or loss through construction operations.

J. Cylinder Compressive Strength Testing:

1. Test Method: Comply with ASTM C 39.
2. Test Acceptance: According to ACI 318.
3. Test one cylinder at seven days.
4. Test one cylinder at fourteen days.
5. Test two cylinders at 28 days.
6. Retain one cylinder for testing when requested by Engineer.
7. Dispose of remaining cylinders if testing is not required.
8. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day or 14-day strengths (where proper relation between seven, 14 and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths without additional compensation.

K. Core Compressive Strength Testing:

1. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. Use results of tests on such cores as basis for acceptance, rejection, or determining the continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve Contractor from meeting specification requirements. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Repair core holes with non-shrink grout as specified in Section 036000 - Grouting. Work of cutting, testing, and repairing the cores will be at the expense of Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of Owner.
2. Sampling and Testing Procedures: Comply with ASTM C 42.
3. Test Acceptance: According to ACI 318.
4. Drill three cores for each failed strength test from failed concrete.

L. Patching:

1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
2. It is the intent of these Specifications to require quality work including forming, mixing, and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.
3. As soon as forms have been stripped and concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.
4. Immediately after removal of forms, remove tie cones and metal portions of ties as specified in Section 031000 - Concrete Forming and Accessories. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16 inch brush coat of neat cement slurry mixed to consistency of a heavy paste. Immediately plug hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.

5. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days as necessary to bring surface down with parent concrete. Do not damage or stain virgin skin of surrounding parent concrete. Wash thoroughly to remove rubbed matter.
6. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

<u>Material</u>	<u>Volumes</u>	<u>Weights</u>
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

7. Patch imperfections according to ACI 301.
8. Defective concrete and honeycombed areas: Chip down square and at least 1 inch 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8 inch wide around the steel. For areas less than 1-1/2 inches deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2 inch layers on successive days, each layer being applied with slurry as described above.

M. Defective Concrete:

1. Description: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.
2. Repair or replacement of defective concrete will be determined by Engineer.
3. Do not patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

3.11 FAILURE TO MEET REQUIREMENTS

- A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1.7E. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Table 1. The cost of such additional curing shall be at no additional cost to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, without additional compensation. In such cases of failure to meet strength requirements, Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C 94. The "purchaser" referred to in ASTM C 94 is the Contractor.

- B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C 42 and C 39. In cases where tests of cores fall below the values given in Table 1, the Engineer, in addition to other recourses, may require load tests on any one of the slabs, walls, beams, and columns in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Perform coring and testing, load tests, and any strengthening or concrete replacement required because strengths of test specimens are below that specified, without additional compensation.
- C. Should the strength of test cylinders fall below 60 percent of required minimum 28 day strength, concrete shall be rejected, removed, and replaced without additional compensation.

3.12 SCHEDULE

- A. Following Table 5 are general applications for various concrete classes and design strengths:

TABLE 5

<u>Class</u>	<u>Design Strength</u> (psi)	<u>Description</u>
A	2,500	Concrete fill, concrete fill for bollards, electrical raceway encasement and pipe encasement.
E1	4,500	Structural concrete foundation mats and slabs, walls, and footings 16 inches and greater in thickness.
E2	4,500	Except as noted above for Class E1 concrete: Structural concrete greater than 10 inches in thickness including walls, slabs on grade, elevated slab and beam systems, columns, grade beams, and all other structural concrete greater than 10 inches in thickness.
E3	4,500	Structural concrete 10 inches or less in thickness including walls, slabs on grade, elevated slab and beam systems, columns and all other structural concrete 10 inches or less in thickness.

END OF SECTION 033000

SECTION 036000 - GROUTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Portland cement grout.
2. Concrete grout.
3. Nonshrink epoxy grout.
4. Nonshrink cementitious grout.

- B. Related Requirements:

1. Section 024119 "Selective Demolition": Demolition and removals.
2. Section 030130 "Maintenance of Cast-In-Place Concrete": Modifications to existing concrete.
3. Section 031000 "Concrete Forming and Accessories."
4. Section 033000 "Cast-in-Place Concrete."
5. Section 033200 "Concrete Reinforcing."
6. Section 042000 "Unit Masonry: Masonry grout."
7. Section 055000 "Metal Fabrications: Grout related to miscellaneous metals."

1.3 ACTION SUBMITTALS

- A. Section 013300 "Submittal Procedures": Requirements for submittals.

- B. Product Data: Submit manufacturer information regarding grout and surface preparation, mixing and installation.

1. Commercially manufactured nonshrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
2. Commercially manufactured nonshrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.
3. Cement grout. Include the type and brand of cement, the gradation of fine aggregate, product data on any proposed admixtures and the proposed grout mix.
4. Concrete grout. Include data as required for concrete as delineated in Section 033000 "Cast-In-Place Concrete."

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing epoxy-type and nonshrink grouts.
- C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- D. Qualifications Statement:
 - 1. Submit qualifications for manufacturer.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of each standard affecting Work of this Section on Site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience in production and use of provided grouts.
- B. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have beneficial interest are not acceptable.
- C. Field testing of concrete grout will be as specified for concrete in Section 033000 "Cast-In-Place Concrete."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 "Product Requirements": Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.
- D. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.
- E. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location.
 - 2. Provide additional protection according to manufacturer instructions.

1.8 AMBIENT CONDITIONS

- A. Section 015000 “Temporary Facilities and Controls”: Requirements for ambient condition control facilities for product storage and installation.
- B. Maximum Conditions: Do not perform grouting if temperatures exceed 90 degrees F.
- C. Minimum Conditions: Do not perform grouting if the minimum temperature of base plates, supporting concrete and grout are less than 40 degrees F. Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 PORTLAND CEMENT GROUT

- A. Portland Cement: Comply with ASTM C 150/C 150M, Type I and II.
- B. Water:
 - 1. Potable.
 - 2. No impurities, suspended particles, algae, or dissolved natural salts in quantities capable of causing:
 - a. Corrosion of steel.
 - b. Volume change increasing shrinkage cracking.
 - c. Efflorescence.
 - d. Excess air entraining.
- C. Fine Aggregate:
 - 1. Washed natural sand.
 - 2. Gradation:
 - a. Comply with ASTM C 33/C 33M.
 - b. Represented by smooth granulometric curve within required limits.
 - 3. Free from injurious amounts of organic impurities according to ASTM C 40/C 40M.
- D. Mix:
 - 1. Portland cement, sand, and water.
 - 2. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 NONSHRINK EPOXY GROUT

- A. Description:
 - 1. Pre-proportioned, prepackaged, three-component, nonshrink epoxy grout, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate.

B. Performance and Design Criteria:

1. Minimum Compressive Strength:
 - a. 10,000 psi at seven days.
 - b. Comply with ASTM C 579.
2. Coefficient of Expansion:
 - a. 30×10^{-6} inch per degree F.
 - b. Comply with ASTM C 531.
3. Minimum Tensile Strength:
 - a. 1,800 psi.
 - b. Comply with ASTM C 307.

C. Products: Provide one of the following:

1. Masterflow 648 CP; by BASF Building Systems.
2. Five Star HP Epoxy Grout; by Five Stars Products, Inc.
3. Sikadur 42 Grout-Pak; by Sika Corp.

2.3 NONSHRINK CEMENTITIOUS GROUT

A. Description:

1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, not containing expansive cement and no chlorides.
3. No shrinkage when tested in conformity with ASTM C 827/C 827M.

B. Performance and Design Criteria:

1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to ASTM C 1107/C 1107M for Grades B, C, D and CRD-C621 nonshrink grout:
 - a. Setting Time:
 - 1) Initial: Approximately two hours.
 - 2) Final: Approximately three hours.
 - 3) Comply with ASTM C 191.
 - b. Maximum Expansion: 0.10 to 0.40 percent.
 - c. Minimum Compressive Strength:
 - 1) One-Day: 4,000 psi.
 - 2) Seven-Day: 7,000 psi.
 - 3) 28-Day: 10,000 to 10,800 psi.
 - 4) Comply with CRD-C621.

C. Products: Provide one of the following:

1. SikaGrout 212 by Sika Corp.
2. NS Grout by the Euclid Chemical Co.
3. Five Star Grout by Five Star Products, Inc.

2.4 CONCRETE GROUT

A. Description: Conform to the requirements of Section 033000 "Cast-In-Place Concrete", except as follows. Proportion with Type II cement, coarse and fine aggregates, water, water reducing admixture, and air entraining agent to produce specified mix performance:

1. Average Strength (ASTM C 579): 3500 psi at 28 days nominal strength.
2. Maximum Coarse Aggregate Size: 3/8-inch .
3. Minimum Cement Content: 540 lbs per cubic yard.
4. Maximum Water to Cement Ratio: 0.45.
5. Maximum Slump: 5 inches.

B. Add synthetic reinforcing fibers as specified in Section 032000 "Concrete Reinforcing" to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Add fibers from manufacturer's pre-measured bags and according to manufacturer's recommendations to ensure complete dispersion of fiber bundles as single monofilaments within the concrete grout.]

2.5 FORMWORK

A. As specified in this Section and in Section 031000 "Concrete Forming and Accessories".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017300 "Execution": Requirements for installation examination.
- B. Verify areas to receive grout.

3.2 PREPARATION

- A. Section 017300 "Execution": Requirements for installation preparation.
- B. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by the Engineer.
- C. Remove defective concrete, ice, laitance, dirt, oil, grease, form release agents, paints and other foreign material from concrete surfaces, which may affect the bond or performance of the grout by brushing, hammering, chipping, sand blasting or other similar dry mechanical means until

sound and clean concrete surface is achieved. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- D. Roughen concrete lightly, but not to interfere with placement of grout.
- E. Remove foreign materials from metal surfaces in contact with grout.
- F. Align, level, and maintain final positioning of components to be grouted.
- G. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of nonshrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, or flooding the surface or other method acceptable to the Engineer. Upon completion of the 24 hour period, remove visible water from the surface prior to grouting.
- H. Nonshrink epoxy grouts do not require saturation of concrete substrate. Do not wet concrete surfaces to receive nonshrink epoxy grout. Completely dry surfaces in contact with epoxy grout before grouting.
- I. Support equipment during alignment and installation of grout by shims, wedges, blocks or other approved means. Prevent bond of shims, wedges and blocking devices by bond breaking coatings and remove after grouting unless otherwise approved by the Engineer. Grout voids created by the removal of shims, wedges, and blocks.

3.3 INSTALLATION - GENERAL

A. Formwork:

1. Construct leakproof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.
3. As specified in Section 031000 "Concrete Forming and Accessories".

B. Mixing - Portland Cement Grout:

1. Use proportions of two parts sand and one part cement, measured by volume.
2. Prepare grout with water to obtain consistency to permit placing and packing.
3. Mix water and grout in two steps:
 - a. Premix using approximately 2/3 of water.
 - b. After partial mixing, add remaining water to bring mix to desired placement consistency and continue mixing two to three minutes.
4. Mix only quantities of grout capable of being placed within 30 minutes after mixing.
5. Do not add additional water after grout has been mixed.
6. Minimum Compressive Strength (ASTM C 579):

- a. In 48 hours: 2,400 psi.
- b. In 28 days 7,000 psi.

C. Placing of Grout:

- 1. Place grout material quickly and continuously.
- 2. Do not use pneumatic-pressure or dry-packing methods.
- 3. Apply grout from one side only to avoid entrapping air.
- 4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
- 5. Thoroughly compact final installation and eliminate air pockets.
- 6. Do not remove leveling shims for at least 48 hours after grout has been placed.

D. Curing:

- 1. Prevent rapid loss of water from grout during first 48 hours by using wet burlap bags, soaker hoses or ponding.
- 2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
- 3. After grout has attained its initial set, keep damp for minimum three days.

E. Reflect all existing underlying expansion joints, partial contraction joints, and construction joints through the grout.

3.4 INSTALLATION - CONCRETE GROUT

- A. Protect and keep the surface clean until placement of concrete grout.
- B. Remove debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Pressure wash the surface. Do not flush debris into tank drain lines.
- C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout by use of saturated burlap bags, soaker hoses or ponding. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste.
- D. Place concrete grout to final grade using the scrapers of the installed mechanical equipment as a guide for surface elevation and to eliminate high and low spots. Unless specifically approved by the equipment manufacturer, do not use mechanical scraper mechanisms powered by their motors as a finishing machine or screed to push grout.
- E. Verify the following if required for project.
- F. Steel trowel finish as specified in Section 033500 "Concrete Finishing." Cure the concrete grout as specified for cast-in-place concrete in Section 033000 "Cast-In-Place Concrete."

3.5 INSTALLATION - NONSHRINK EPOXY GROUTS

- A. Mix in accordance with manufacturer's recommendations. Mix full batches only, to maintain proper proportions of resin, hardener and aggregate. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Do not entrain air bubbles by mixing too quickly.
- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 degrees F or above 90 degrees F.
- C. Place grout rapidly and continuously to avoid cold joints. Place grout in lifts in accordance with manufacturer's recommendations.
- D. Provide forms as specified in Paragraph 3.3A. Place grout into the designated areas and prevent entrapment of air. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.
- E. Minimize 'shoulder' length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- F. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- G. Epoxy grouts are self-curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1,000 psi or as recommended by the manufacturer, whichever is longer.
- H. Provide grout control joints as indicated on Drawings.

3.6 SCHEDULE

- A. Use particular types of grout as follows:
 - 1. General Purpose Nonshrink Cementitious Grout (CRD-C621 Grade D): Use at locations where nonshrink grout is indicated, except for base plates greater in area than 3-feet wide by 3-feet long.
 - 2. Flowable (precision) Nonshrink Cementitious Grout (CRD-C621 Grade B or C): Use under base plates greater in area than 3-feet wide by 3-feet long. Use at locations indicated to receive flowable (precision) nonshrink grout. Flowable (precision), nonshrink, cementitious grout may be substituted for general purpose nonshrink cementitious grout.
 - 3. Nonshrink Epoxy Grout: Use at all locations specifically indicated to receive nonshrink epoxy grout.
 - 4. Portland Cement Grout: Use where indicated.

END OF SECTION 036000

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Concrete masonry units.
 - 2. Mortar and grout.
 - 3. Masonry-joint reinforcement.
 - 4. Ties and anchors.
 - 5. Miscellaneous masonry accessories.
 - 6. Masonry-cell fill.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - 2. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 3. Grout mixes. Include description of type and proportions of ingredients.
 - 4. Joint reinforcement.
 - 5. Anchors, ties, and metal accessories.

- B. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
 - 2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- C. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- D. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

1.8 FIELD CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
 - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.
 - 2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C1314.

2.2 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

2.3 CONCRETE MASONRY UNITS

- A. CMUs: ASTM C90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
 - 2. Density Classification: Normal weight.
 - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 - 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C91/C91M.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Cemex S.A.B. de C.V.
 - b. Holcim (US) Inc.

c. Lafarge North America Inc.

- E. Aggregate for Mortar: ASTM C144.
 - 1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
- F. Aggregate for Grout: ASTM C404.
- G. Water: Potable.

2.5 REINFORCEMENT

- A. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
 - 1. Interior Walls: Hot-dip galvanized carbon steel.
 - 2. Wire Size for Side Rods: 0.187-inch diameter.
 - 3. Wire Size for Cross Rods: 0.187-inch diameter.
 - 4. Wire Size for Veneer Ties: 0.187-inch diameter.
 - 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 - 6. Provide in lengths of not less than 10 feet.
- B. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

2.6 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
 - 1. Stainless-Steel Wire: ASTM A580/A580M, Type 316.
- C. Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.031-inch-thick, stainless-steel sheet.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

2.8 MASONRY CLEANERS

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

2.9 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime masonry cement mortar unless otherwise indicated.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 - 1. For reinforced masonry, use Type S.
- D. Grout for Unit Masonry: Comply with ASTM C476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C476, paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
 - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION, GENERAL

- A. Thickness: Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2-inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2-inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- G. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.5 MORTAR BEDDING AND JOINTING

- A. Lay CMUs as follows:
 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
 3. Bed webs in mortar in grouted masonry, including starting course on footings.
 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
 5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- C. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
- D. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
- E. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content and compressive strength.
- F. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.
- G. Prism Test: For each type of construction provided, according to ASTM C1314 at 7 days and at 28 days.

3.7 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.8 MASONRY WASTE DISPOSAL

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

END OF SECTION 042000

SECTION 050519 - POST-INSTALLED ANCHORS AND REINFORCING BARS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Post-installed adhesive and expansion anchors for concrete and concrete masonry unit substrates.
 - 2. Post-installed reinforcing bar dowels using adhesive anchoring system.

- B. Related Requirements:

- 1. Section 033000 "Cast-In-Place Concrete" and related Sections for concrete, reinforcement, and accessories.
 - 2. Section 042000 "Unit Masonry" for concrete masonry units and accessories.
 - 3. Various Sections in Division 05 related to metals.
 - 4. Various Sections in Divisions 22, 23, and 26 related to facility utilities.
 - 5. Various Sections in Divisions 40 and 43 related to process mechanical equipment.

1.3 ACTION SUBMITTALS

- A. Submit in accordance with Section 013300.

- B. Post-Installed Expansion Anchors:

- 1. Design Data: Submit manufacturer's specifications and data including recommended design values and physical characteristics for expansion anchors.
 - 2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed expansion anchors installed into cracked concrete and masonry.
 - 3. Installation Procedures: Submit procedures stating product proposed for use, and complete installation method.

- C. Post-Installed Adhesive Anchoring System:

- 1. Design Data: Submit manufacturer's specifications and data including recommended design values and physical characteristics, including temperature, humidity, and moisture limitations for adhesive anchoring system.
 - 2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed adhesive anchoring system installed into cracked concrete and masonry.

3. Installation Procedures: Submit procedures stating method of drilling, product proposed for use, and complete installation method.

1.4 INFORMATIONAL SUBMITTALS

- A. Installation procedure: Submit installation procedure for post-installed adhesive anchoring system; including method of drilling.
- B. Certificates:
 1. Installer Qualifications for Adhesive Anchoring System: Submit installer and testing agency qualifications as stated in following Paragraph of this Article.
 2. Submit current International Code Council (ICC) Evaluation Service Reports (ESR) for expansion anchors and adhesive anchoring system, for installation into cracked concrete or masonry, as applicable, indicating conformance with current ICC Evaluation Service (ICC-ES) Acceptance Criteria.
- C. Qualification Data:
 1. Installer: Indicate manufacturer's training date and a list of personnel trained on installation of adhesive anchoring system.
 2. Testing Agency:
 - a. Laboratory: Meet requirements of ASTM E329. Prior to testing, submit qualifications of proposed testing laboratory for approval that includes:
 - 1) Name and address.
 - 2) Names and positions of principal officers and name, position, and qualifications of responsible registered professional engineer in charge.
 - 3) List technical services provided, indicating external technical services to be provided by other organizations.
 - 4) Names and qualifications of the supervising laboratory technicians.
 - 5) Provide report prepared by laboratory evaluations authority when requested by The Engineer.
 - 6) Submit as required above for other organizations that will provide external technical services.
 - b. Include in submittal a list of five projects in which the laboratory has performed testing in accordance with ASTM E488. Include following information for each project:
 - 1) Project name and location.
 - 2) Project Owner.
 - 3) Owner's representative including address and phone number.
 - 4) Brief description of work.
 3. Submit qualifications of other laboratory or laboratories until approved.

- D. Evaluation Reports: From ICC-ES for expansion anchors and adhesive anchoring system, for installation of post-installed anchors into cracked concrete or [concrete masonry unit, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

1.5 QUALITY ASSURANCE

- A. General: Coordinate with the work of other Sections, field verifying dimensions and work of other trades adjoining items of work before installing items specified in this Section.
- B. Representatives of post-installed anchor system manufacturer:
 - 1. Performance Testing: Be on site for installation of anchor and reinforcing bars and performance testing of adhesive anchoring system of their respective products system, subsystem, or component. Observe, guide and provide instruction on Contractor's assembly, erection, installation or application procedures during the drilling, placement, injection and testing. Inspect, check, and make adjustments as required for the product to function as warranted by the manufacturer and as necessary to furnish the Manufacturer's Certification of Proper Installation.
- C. Adhesive Anchoring System:
 - 1. Installer Training: Conduct thorough training by the manufacturer or the manufacturer's representative. Training shall consist of the complete installation process for post-installed anchors and reinforcing bar dowels, including but not limited to:
 - a. Tool selection.
 - b. Hole drilling procedure.
 - c. Hole preparation and cleaning techniques.
 - d. Adhesive injection technique and dispenser training and maintenance.
 - e. Anchor preparation and installation.
 - f. Reinforcing bar dowels preparation and installation.
 - g. Proof loading and torqueing.
 - h. Temperature, humidity, and moisture limitations.
 - i. Working time limitations.
 - j. Setting time.
 - 2. Include training for anchors and reinforcing bar dowels installed horizontally or upwardly inclined to support sustained tension loads. Install horizontally or upwardly inclined anchors and reinforcing bar dowels by personnel certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchor Installer Certification program, or equivalent.
 - 3. Manufacturer's Certificate of Proper Installation: Submit upon completion of work, for the post-installed anchors and reinforcing bar dowels, including non-production and production anchors and reinforcing bar dowels.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

- B. Handle materials with cranes or derricks. Do not dump material off transportation vehicles or handle in ways that will cause damage.
- C. Store materials elevated above grade and block up so they will not become bent or otherwise damaged.
- D. Repair items that have become damage or corroded to satisfaction of the Engineer prior to incorporating them into the work.

PART 2 - PRODUCTS

2.1 EXPANSION ANCHORS

- A. Fastening to Concrete Substrate: Zinc plated carbon steel wedge type anchors, complete with zinc plated nuts and washers, unless otherwise noted.
- B. Submerged or Weather Exposed Substrates: ASTM A276 Type 316 stainless steel wedge type anchors, complete with Type 316 stainless steel nuts and washers, unless otherwise noted.
- C. Meet ICC ES AC01 or ICC ES AC193.
- D. Length: When length or anchor embedment is not indicated, provide length sufficient to place the wedge and expansion cone portion of the anchor at least 1 inch behind concrete reinforcing steel.
- E. Basis-of-Design:
 - 1. Anchorage designs indicated are based on Hilti, Kwik-Bolt TZ, unless otherwise noted.
 - 2. Acceptable Anchors: Hilti Kwik-Bolt TZ; Simpson Strong-Tie Strong Bolt 2 Wedge Anchor; DeWalt Power-Stud+ SD1 or DeWalt Power-Stud+ SD6 for stainless steel.

2.2 ADHESIVE ANCHORING SYSTEM

- A. Fastening to Concrete Substrate: Manufactured system consisting of post installed threaded rods, nuts, washers, other anchoring hardware, and chemical dispenser for installation in hammer drilled holes.
 - 1. Anchors: Meet ICC ES AC308.
 - 2. Injection Adhesive: Two-component epoxy system consisting of a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep both components separate.
 - 3. Adhesive Cartridge: Side-by-side design to accept a static mixing nozzle which thoroughly blends both components and allows injection directly into a drilled hole.
 - 4. Anchor: Zinc plated carbon steel or Type 316 stainless steel as indicated consisting of an all-thread anchor rod with nut and washer, of matching material to anchor rod.
 - a. Basis-of-Design:
 - 1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.

- 2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5.
5. Reinforcing Bar Dowels: Reinforcing bar, per Section 032000.
 - a. Basis-of-Design:
 - 1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
 - 2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5.
- B. Fastening to Hollow Concrete Block, Brick, or Hollow-Core Precast Concrete Planks: Three-part threaded rod, screen tube, and chemical dispenser anchoring system.
 1. Anchors: Meet ICC ES AC58.
 2. Adhesive Cartridges: Contain pre-measured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser.
 3. Anchor: Zinc plated carbon steel or Type 316 stainless steel as indicated consisting of an all-thread anchor rod with nut and washer, of matching material to anchor rod.
 4. Reinforcing Bar Dowel: Reinforcing bar, per Section 032000.
 5. Basis-of-Design:
 - a. Anchorage designs indicated are based on Hilti HIT HY-270 System, unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Install anchoring system in strict compliance with manufacturer's published installation instructions and approved Shop Drawings. Comply with recommended surface preparation, temperature, and moisture of substrate and ambient conditions.
 2. Coordinate installation with Special Inspector.
 3. Use drill bit of correct diameter and drill to required depth using rotary impact type hammer drills with carbide-tipped bits.
 4. Drill holes perpendicular to concrete surface, unless otherwise indicated.
 5. Use oil free compressed air to blast out loose particles and dust from drilled holes.
- B. Expansion anchors:
 1. Check expansion anchors for tightness a minimum of 24 hours after initial installation.

C. Adhesive anchoring system:

1. Perform installation only by personnel trained in anchor installation and having certification required in PART 1 - GENERAL.
2. Inject adhesive and install anchors or reinforcing bar dowels that are clean and free of dirt, oil, grease, ice or other deleterious material which would reduce bond.

3.2 REPAIRS

- A. At testing completion, repair damaged concrete, post-installed anchors, reinforcing bar dowels and other damaged construction as required to match conditions prior to testing.
- B. Repair in accordance with provisions of Section 030130.71 "Modifications to Existing Concrete", including but not limited to:
 1. Saw cutting and removal of damaged, loose, or unsound concrete.
 2. Removal of damaged anchors and reinforcing bar dowels.
 3. Cleaning and preparing concrete surface and reinforcing bar dowels.
 4. Place new repair material.
 5. Install new anchors and reinforcing bar dowels to replace anchors and reinforcing bar dowels that are found to be unacceptable or deficient.
 6. Perform repairs at no additional cost to Owner.

END OF SECTION 050519

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Note that some items in list below are not described in detail in Part 2. These items are covered by material requirements and articles such as "Miscellaneous Framing and Supports," but they must be indicated in detail on Drawings. Also note that steel framing, supports, elevator machine beams, hoist beams, divider beams, and door frames that are attached to steel frame are specified in Section 051200 "Structural Steel Framing."
2. Retain first subparagraph below if steel angles or other shapes are used to support countertops between cheek walls.
3. Steel framing and supports for mechanical and electrical equipment.
4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
5. Steel beams.
6. Steel angles.
7. Steel lintels.
8. Steel stairs.
9. Steel support brackets.
10. Steel base plates for other than structural steel or equipment.
11. Steel closure plates.
12. Steel bridge crane rails.
13. Steel holddown straps and lugs.
14. Steel splice plates.
15. Steel subframing at roof openings.
16. Shelf angles.
17. Miscellaneous items fabricated from steel, aluminum or stainless steel.
18. Aluminum beams.
19. Aluminum angles.
20. Aluminum closure angles.
21. Aluminum grates.
22. Aluminum diamond plate and floor plate.
23. Aluminum stop plates.
24. Aluminum stair nosings.
25. Aluminum stair treads
26. Aluminum nosing.
27. Aluminum bar racks.
28. Stainless steel beams.

29. Stainless steel angles.
30. Stainless steel bar racks.
31. Crane rails in following subparagraph can be provided by this Section or with the crane assembly as specified in Section 412213.13 "Bridge Crane". Coordinate with specification writer editing that Section to determine where rails are to be specified.
32. Bridge crane runway rails.
33. Castings.
34. Retain first subparagraph below for elevator pit ladders and other metal ladders.
35. Metal ladders.
36. Fall Prevention Systems.
37. Alternating tread devices.
38. Metal floor plate and supports.
39. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading-dock edge angles.
40. Metal bollards.
41. Delete first subparagraph below if nosings and treads are specified with stairs and if cast-metal thresholds are specified with hardware.
42. Abrasive metal nosings, treads and thresholds.

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

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 036000 "Grouting" for non-shrink grout.
3. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
4. Section 050519 "Post-Installed Anchors and Reinforcing Bars" for anchors in various substrates.
5. Various Sections in Divisions 40 - 46 for process mechanical work scopes.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Prefabricated building columns.
3. Metal nosings and treads.
4. Paint products.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for overhead doors and grilles.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Shelf angles.
5. Metal ladders.
6. Fall Prevention System.
7. Alternating tread devices.
8. Metal floor plate and supports.
9. Miscellaneous steel trim including steel angle corner guards steel edgings and loading-dock edge angles.
10. Metal bollards.
11. Abrasive metal nosings treads and thresholds.
12. Loose steel lintels.
13. Miscellaneous steel items.
14. Miscellaneous aluminum items.
15. Miscellaneous stainless steel items.

C. Delegated-Design Submittal: For ladders and platforms, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Mill Certificates: Signed by aluminum, steel and stainless steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

1. Certify that welders have been qualified under AWS, within previous 12 months, to perform welds required under this Section.

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

1.6 QUALITY ASSURANCE

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

1.7 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders.
- B. Structural Performance of Aluminum Ladders: Aluminum ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Wide Flange Shapes: ASTM A992.
- C. Steel Other Shapes, Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Stainless steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 316, Type 316L for welded components.
- E. Stainless steel Bars and Shapes: ASTM A 276, Type 316, Type 316L for welded components.
- F. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

- G. Rolled-Stainless Steel Floor Plate: ASTM A 793.
- H. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface.
- I. Steel Tubing: ASTM A 500/A 500M, Grade B cold-formed steel tubing.
- J. Steel Pipe: ASTM A 53/A 53M, Type S Grade B Standard Weight (Schedule 40) unless otherwise indicated.
- K. Zinc-Coated Steel Wire Rope: ASTM A 741.
 - 1. Wire-Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
- L. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: As indicated.
 - 2. Material: Galvanized steel, ASTM A 653/A 653M with G90 coating.
 - 3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, hot-dip galvanized after fabrication.
- M. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- N. Aluminum Extruded Pipe: ASTM B429, Alloy 6063 T6 and Alloy 6061 T6 as indicated.
- O. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- P. Aluminum Extrusions: ASTM B 221, Alloy 6061 T6.
- Q. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- R. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
- S. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
- T. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).
- U. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.
- V. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).
- W. Gray Iron Castings: ASTM A48, Class 35.
- X. Ductile Iron Castings: ASTM A536, Grade 65-45-12.
- Y. Stainless steel Bolts: ASTM F593, Type 316.
- Z. Stainless steel Nuts: ASTM F594, Type 316.

- AA. Carbon Steel Bolts and Studs: ASTM A307, Grade A (hot dip galvanized nuts and washers where noted)
- BB. High Strength Steel Bolts, Nuts and washers: ASTM F3125, Grade A325 (mechanically galvanized per ASTM B695, Class 50, where noted).
 - 1. Elevated Temperature Exposure: Type I.
 - 2. General Application: Type I or Type II.
- CC. Galvanizing: ASTM A123, Zn w/0.05 percent minimum Ni.
- DD. Galvanizing, hardware: ASTM A153, Zn w/0.05 percent minimum Ni.
- EE. Galvanizing, anchor bolts: ASTM F2329, Zn w/0.05 percent minimum Ni.
- FF. Welding electrodes, steel: AWS A5.1 E70xx.

2.3 FASTENERS

- A. Unless otherwise noted, provide steel machine bolts for the connection of carbon steel or iron; galvanized steel or stainless-steel machine bolts for the connection of galvanized steel or iron; and stainless steel machine bolts for the connection of aluminum or stainless-steel.
- B. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum.
 - 2. Provide stainless steel fasteners for fastening stainless steel.
 - 3. Provide stainless steel fasteners for fastening nickel silver.
 - 4. Provide bronze fasteners for fastening bronze.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- D. Mechanically Galvanized Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM F 3125, Grade A325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.
- E. Stainless steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 2.
- F. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Provide standard headed bolts with heavy hex nuts and Grade A washers.
 - 2. Where galvanized anchor bolts are indicated or specified, provide standard headed bolts with heavy hex nuts and Grade A washers, galvanize in accordance with ASTM F 2329.
- G. Automatic End Welded Headed Anchor Studs and Flux Ended Studs: Cold drawn steel, ASTM A 108, Grades C-1010 through C-1020.

1. Basis-of-Design - Headed Anchor Studs as Manufactured by Nelson or equal: H4L Headed Concrete Anchors.
- H. Machine bolts and nuts conforming to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.
- I. Toggle Bolts: shall be Hilti, Toggler Bolt or equal.
- J. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- K. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts

2.4 MISCELLANEOUS ALUMINUM

- A. Miscellaneous Aluminum: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal threads on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Weld on unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous Aluminum Items: Beams, angles, closure angles, grates, floor plates, stop plates, stair nosings, and other miscellaneous aluminum indicated and not otherwise specified.
- D. Angle Frames for Roof Hatches, Beams, Grates, and Similar Items: Complete with welded strap anchors attached.
- E. Stair Treads for Aluminum Stairs: As specified for grating and having cast abrasive non-slip nosing as approved.
- F. Aluminum Nosing at Concrete Stairs: Furnish with wing type anchors and flat head stainless steel machine screws, 12 inches on center. Single piece nosing for each step extending to within 3 inches at each side of stair. Set nosing flush with stair tread finish at concrete stairs. Furnish treads with heavy duty protective tape cover.
 1. Basis-of-Design: Wooster Products, Inc.; Alumogrit Treads, Type 116; similar by Barry Pattern and Foundry Co.; Andco or equal.

G. Aluminum Finishes:

1. Anodized Finish: Give an anodic oxide treatment in accordance with AA M31C22A41 for items noted in the Drawings.
2. Mill Finish: Have a cleaned and degreased mill finish on other aluminum items.

2.5 MISCELLANEOUS STEEL

- A. Miscellaneous Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal thread on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Miscellaneous Steel Items: Beams, angles, lintels, metal stairs detailed on the Drawings, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold-down straps and lugs, door frames, splice plates, subframing at roof openings and any other miscellaneous steel indicated and not otherwise specified.
- D. Bridge crane runway rails: 40 lb ASCE. Stagger rail splices. Fasten rails with rail clamp plates, fillers, and pairs of anchor bolts every 2-ft. Provide steel base plates below the filler and a continuous strip of neoprene under the rail between base plates, at rails on concrete.
- E. Structural steel angle and channel door frames: Galvanized. Fabricated with not less than three anchors on each jamb.
- F. Steel pipe pieces for sleeves, lifting attachments and other functions: Schedule 40 pipe unless otherwise indicated. Wall and floor sleeves, of steel pipe: Provide welded circumferential steel waterstops at mid-length.
- G. Lintels, relief angles or other steel supporting masonry or embedded in masonry: Galvanized.
- H. Steel Finish Work: Thoroughly cleaned, by effective means, of loose mill scale, rust and foreign matter. Provide one shop coat of primer compatible with finish coat after fabrication but before shipment. Omit paint within 3 inches of proposed field welds. Apply paint to dry surfaces and be thoroughly and evenly spread and well worked into joints and other open spaces.
- I. Galvanizing, where required: Use hot-dip zinc process after fabrication, coating not less than 2 oz/sq.ft. of surface.

2.6 MISCELLANEOUS STAINLESS-STEEL

- A. Miscellaneous Stainless-Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.
- B. Connections and accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints, jointed where least conspicuous. Conceal threads on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Provide holes for temporary field connections and for attachment of the work of other trades.
- C. Beams, angles, bar racks, and other miscellaneous stainless steel.

2.7 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099100 "Painting," and Section 099010 Shop Priming.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A 780 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.8 CASTINGS:

- A. General: Good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes, and other defects. Thoroughly clean castings to remove foreign matter, and deleterious films. Castings will be subjected to a hammer inspection in the field by the Engineer. Damaged castings may be rejected and replaced at no cost to the Owner.
- B. Matching Surfaces: Machine to a true plane surface allowing contact surfaces to seat without rocking. Provide allowances in patterns so specified thickness is not reduced to obtain finished

surfaces. Castings will not be acceptable if actual weight is less than 95 percent of theoretical weight computed from dimensions. Provide facilities for weighing castings in the presence of the Engineer.

2.9 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/4 by 1 inch, with a minimum 6 inch embedment and 1 1/2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.10 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.11 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
 - 1. Provide mitered and welded units at corners.
 - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
- B. Galvanize and prime shelf angles located in exterior walls.
- C. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.12 METAL LADDERS

- A. General:
 - 1. Comply with ANSI A14.3.
 - 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
- B. Aluminum Ladders:
 - 1. Space siderails minimum 18 inches apart, unless otherwise indicated.
 - 2. Siderails: Continuous aluminum bars 1/2-by-2-1/2-inch.
 - 3. Rungs: Solid extruded-aluminum tubes, 3/4 inch diameter.
 - 4. Fit rungs in centerline of siderails; fasten as indicated.
 - 5. Wall Support Brackets: Aluminum 6061-T6 spaced 4 feet on center with Type 316 stainless steel fasteners. Fasten side rails to floor with 1/2 inch diameter Type 316 stainless steel expansion anchors.
 - 6. Platforms: Fabricate from pressure-locked aluminum bar grating, supported by extruded-aluminum framing. Limit openings in gratings to no more than 1/2 inch in least dimension.
 - 7. Support each ladder at top and bottom and not more than 48 inches o.c. with welded or bolted aluminum brackets.
 - 8. Provide minimum 72-inch- high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use where indicated in Drawings.

2.13 COVER PLATE

- A. Fabricate aluminum diamond plate and floor plate having a minimum thickness of 3/8 inch. Fabricate frames and supports of aluminum construction. Fastening devices and hardware shall be Type 316 stainless-steel. Plates shall have a mill finish.
- B. Provide aluminum angle supports as indicated.
- C. Include aluminum angle stiffeners, and fixed and removable sections as indicated.
- D. Provide flush stainless steel bar drop handles for lifting removable sections, one at each end of each section.

2.14 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize miscellaneous steel trim.

2.15 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
 - 1. Cap bollards with round off top.
 - 2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
 - 3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
- B. Fabricate bollards with 3/8-inch- thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.
 - 1. Provide 1-inch minimum of nonshrink grout beneath bollard base plate to allow for plumb alignment of bollards.
- C. Fabricate sleeves for bollard anchorage from steel pipe with 1/4-inch- thick steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.
- D. Fabricate internal sleeves for removable bollards from Schedule 40 steel pipe or 1/4-inch wall-thickness steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch steel machine bolt.

- E. Prime bollards with zinc-rich primer.

2.16 ALUMINUM METAL NOSINGS, TREADS AND THRESHOLDS

- A. Cast-Metal Units: Cast iron aluminum, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
 - 1. Nosings: Cross-hatched units, 4 inches wide with 1/4-inch lip, for casting into concrete.
 - 2. Nosings: Cross-hatched units, 1-1/2 by 1-1/2 inches, for casting into concrete.
 - 3. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch nosing, for application over bent plate treads or existing stairs.
 - 4. Thresholds: Fluted-saddle-type units, 5 inches wide by 1/2 inch high, with tapered edges.
 - 5. Thresholds: Fluted-interlocking- (hook-strip-) type units, 5 inches wide by 5/8 inch high, with tapered edge.
 - 6. Thresholds: Plain-stepped- (stop-) type units, 5 inches wide by 1/2 inch high, with 1/2-inch step.
- B. Extruded Units: Aluminum, with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.
 - 1. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
 - 2. Provide solid-abrasive-type units without ribs.
 - 3. Nosings: Square-back units, 4 inches wide, for casting into concrete steps.
 - 4. Nosings: Beveled-back units, 3 inches wide with 1-3/8-inch lip, for surface mounting on existing stairs.
 - 5. Nosings: Two-piece units, 3 inches wide, with subchannel for casting into concrete steps.
 - 6. Treads: Square-back units, full depth of tread with 1-3/8-inch lip, for application over existing stairs.
- C. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- D. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
 - 1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.

2.17 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.
- C. Prime plates with zinc-rich primer.

2.18 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles or shapes and plates of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Size loose lintels to provide bearing length at each side of openings of 8 inches unless otherwise indicated.
- C. Galvanize and prime loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.19 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.20 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.21 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products. Limit maximum nickel (Ni) content of galvanizing zinc to 0.05%.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with primers specified in Section 099010 "Shop Priming" unless zinc-rich primer is indicated.
- D. Preparation for Shop Priming: Prepare surfaces per Section 099010 "Shop Priming."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.22 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 03 and Division 04 respectively. Install items to be attached to concrete or masonry after such work is completed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.
- B. Touch up abrasions in the shop primer immediately after erection. Paint areas left unprimed for welding after welding.
- C. Clean and repair, after installation, zinc coating which has been burned by welding, abraded, or otherwise damaged. Thoroughly clean damaged area and remove all traces of welding flux and loose or cracked zinc coating prior to painting. Paint the cleaned area per the requirements of ASTM A780.
- D. Install specialty products in accordance with the manufacturer's recommendations.
- E. Weld headed anchor studs in accordance with manufacturer's recommendations.
- F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- G. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- H. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- I. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for

use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

- J. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- K. Corrosion Protection: Coat concealed surfaces of aluminum and steel that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Aluminum Contacting a Dissimilar Metal: Apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
 - 2. Aluminum Contacting Masonry or Concrete: Apply a heavy coat of approved alkali resistant paint to the masonry or concrete.
 - 3. Aluminum Contacting Wood: Apply two coats of aluminum metal and masonry paint to the wood.
 - 4. Steel Contacting Exposed Concrete or Masonry: Apply heavy bitumastic troweling mastic.
 - 5. Between aluminum stair treads, and steel supports, insert 1/4 inch thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for ceiling hung toilet partitions operable partitions and overhead doors securely to, and rigidly brace from, building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
 - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.
 - 1. Do not fill removable bollards with concrete.

- B. Anchor bollards to existing construction with expansion anchors. Provide four 7/8-inch bolts at each bollard unless otherwise indicated.
 - 1. Embed anchor bolts at least 4 inches in concrete.
- C. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.
- D. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- E. Anchor internal sleeves for removable bollards in concrete by inserting in pipe sleeves preset into concrete. Fill annular space around internal sleeves solidly with nonshrink grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward internal sleeve.
- F. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
- G. Place removable bollards over internal sleeves and secure with 3/4-inch machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.
- H. Fill bollards solidly with concrete, mounding top surface to shed water.
 - 1. Do not fill removable bollards with concrete.

3.4 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.
- C. Seal thresholds exposed to exterior with elastomeric sealant complying with Section 079200 "Joint Sealants" to provide a watertight installation.

3.5 INSTALLING BEARING AND LEVELING PLATES

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

3.6 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099100 " Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 055200 - METAL RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Aluminum pipe guardrails, railings, balusters, and fittings.
 - 2. Handrails.

- B. Related Requirements:

- 1. Section 033000 "Cast-In-Place Concrete": Execution requirements for placement of anchors, as specified in this Section, in concrete.
 - 2. Section 042000 "Unit Masonry": Execution requirements for placement of anchors, as specified in this Section, in masonry.
 - 3. Section 055000 "Metal Fabrications": Attachment plates and angles for metal stairs, including anchorage.

1.3 ACTION SUBMITTALS

- A. Section 013300 "Submittal Procedures": Requirements for submittals.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
- C. Submit calculations or test data demonstrating that the railings will resist the loads specified in the Florida Building Code and/or OSHA at the post spacing provided. Calculations shall be stamped by a professional engineer registered in Florida.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- B. Test Reports: Certified copy of mill test reports on each aluminum proposed for use showing physical properties and chemical analysis.
- C. Certificates: Certify that welders have been qualified under AWS within previous 12 months to perform required welds.

- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- E. Submit certification that the railing system is in compliance with OSHA requirements and the Florida Building Code.
- F. Qualifications Statements:
 - 1. Submit qualifications for fabricator and erector.
 - 2. Submit manufacturer's approval of fabricator and erector.

1.5 QUALITY ASSURANCE

- A. Perform Work for structural aluminum according to AA ADM 1.
- B. Finish welded joints according to NOMMA Guideline 1, Finish #1.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- D. Maintain on-site one copy of each standard affecting the Work of this Section.

1.6 QUALIFICATIONS

- A. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' documented experience.
- B. Erector: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 EXISTING CONDITIONS

- A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide 2 rail welded or mechanically fastened pipe railing systems as indicated, fabricated with 1-1/2 inch nominal diameter pipe. Provide Schedule 80 pipe posts, minimum and rails and handrail of Schedule 40 pipe, minimum. Provide continuous posts and top rails. Spacing of posts not to exceed 5 feet on center and shall be uniformly spaced except as otherwise indicated. Include posts on each side of structure expansion joints. Install railing posts in vertical position.
 - 1. Welding: Provide circumferential welds ground smooth and even to produce a railing that is neat in appearance and structurally sound. Weld in conformity with AWS standards for materials being joined. Cope and fasten rail to post connections with continuous welds. Provide handrail system free of burrs, sharp edges or protrusions on welds. Clean and hand buff welds after fabrication so welds and surrounding area blend with the adjacent finish.
 - a. For welding aluminum, use a weld filler alloy that is compatible with alloys to be joined, that will not discolor the pieces to be joined, and that will not be discolored by anodizing.
 - 2. Mechanical Fasteners: Locate unobtrusively in countersunk holes with the top, flush with rail surface.
 - 3. Bending: Form bends in railings as indicated. No distortion of circular railing shape will be allowed. Make bends and terminal sections without use of fittings. Provide corner bends mitered and welded.
- B. Assemble railing in sections as long as practical, but not greater than 24 feet in length. Provide field splice when an assembled section is to be attached to another section. Provide field splices in railing panels that cross over structure expansion joints.
 - 1. Field Splices: Use internal splice sleeves located within 8 inches of railing posts. Weld sleeves to rails on one side and fasten with set screws to rails on other side. Detail field splice to take differential expansion between railing system and the supporting structure.
 - 2. When field splice occurs in a railing panel crossing a structure expansion joint, weld sleeves to rails on one side and be free to slide in the rails on other side. Detail field splice to take same movement as structure expansion joint.
- C. Provide bases or supports for railing posts and handrail as indicated.
 - 1. Where guardrail and handrail are to be fastened to walls, provide screwed wall flanges fastened to walls with three 3/8 inch stainless-steel expansion anchors. The horizontal projection of handrail support off the wall shall provide 2-1/4 inch minimum clearance around the handrail.
- D. For railing openings, fabricate safety gates of matching pipe and rail material and configuration. Provide self-closing gates with approved stop, latch, and stainless-steel closure spring and hinges.

- E. For railing openings, fabricate barrier chains of stainless-steel having 1/4 inch links, with eleven links per foot. Fasten chains to handrail posts at elevation of each rail. Connect one end of each chain to one post with a 1/4 inch diameter stainless-steel eye bolt and other end connected to other post by means of a heavy chromium plated bronze swivel eye slide harness snap and a similar eye bolt.
 - 1. Acceptable Manufacturers: Eastern Chain Works, Inc., NY; Lawrence Metal Products, Inc.; or equal.
- F. Provide toe boards on railings adjacent to a drop elevation of 4 feet or more. Toeboards are not required on inclined portion of stairway railings or where concrete or steel curbs exist at 4 inches or more in height. Provide toeboards fabricated of 4 inch high channels of same material as railing, having a minimum thickness of 1/8 inch and flanges of not less than 3/4 inch or more than 1-1/2 inch in width. Position toeboards with a maximum clearance of 1/4 inch from floor and fasten to railing posts with 1/4 inch stainless-steel U-bolts, with J-bolts at corner posts, and with clip angles and two 1/4 inch stainless-steel expansion bolts at walls.
- G. Protect railings by paper, an approved coating, or both against scratching, splashes of mortar, paint, or other defacements during transportation, erection, and until adjacent work is complete. Remove protective materials and make surfaces clean and free from stains, marks, or defects.

2.2 MATERIALS

- A. Aluminum Railing System: provide a welded or mechanically fastened, seamless, extruded aluminum pipe system.
 - 1. Rails: ASTM B 429 Alloy 6063-T6.
 - 2. Posts: ASTM B 429 Alloy 6061-T6.
 - 3. Splice and reinforcing sleeves, brackets, end caps, toeboards, and similar components: ASTM B 221 or ASTM B 209, Alloy 6063-T6 or 6061-T6.
 - 4. Cast Fittings: ASTM B 26/B 26M, Alloy No. 214.
 - 5. Railing System Fastening Hardware: ASTM A 276, Type 316 stainless-steel.
 - 6. Finishes: Mill finish..

2.3 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 - 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

2.4 FABRICATION

- A. Fit and shop-assemble components in largest practical sizes for delivery to Site, but not to exceed 24ft in length.
- B. Fabricate components with joints tightly fitted and secured. Furnish spigots and sleeves to accommodate site assembly and installation.
- C. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required. Maintain cylindrical cross section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, and consistent with design of component, except where otherwise noted.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where otherwise noted.
- F. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- G. Accurately form components to suit stairs and landings, to each other, and to building structure.
- H. Accommodate expansion and contraction of members and building movement without damage to connections or members.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive Work.
- B. Verify that concealed blocking and reinforcement are installed and correctly located to receive wall-mounted handrails.

3.2 PREPARATION

- A. Clean and strip aluminum where site welding is required.
- B. Supply items required to be cast into concrete and embedded in masonry with setting templates to appropriate Sections in other Divisions.

3.3 INSTALLATION

- A. Install items, except those to be embedded in concrete under Division 03 or installed in masonry under Division 04. Install items to be attached to concrete or masonry after such work is completed in accordance with indicated details. Do not fasten to wood plugs in masonry.

- B. Install components plumb, level, and square, accurately fitted, and free from distortion or defects.
- C. Anchor railings to structure with anchors, plates and angles.
- D. Field-weld anchors as indicated on Drawings and Shop Drawings. Clean and repair zinc coating which has been burned by welding, abraded, or otherwise damaged. Grind welds smooth. Thoroughly clean damaged area by wire brushing with traces of welding flux and loose or cracked zinc coating removed prior to painting. Touch up damaged galvanizing and coat ends of galvanized railing in the field using the brush-on method to a dry film thickness of not less than 6 mils in accordance with ASTM A 780.
- E. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- F. Assemble with spigots and sleeves to accommodate tight joints and secure installation.
- G. Protect steel surfaces that come into contact with exposed concrete or masonry with a protective coating of an approved heavy bituminous troweling mastic applied in accordance with manufacturer's instructions prior to installation.
- H. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
- I. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to masonry or concrete. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.
- J. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.
- K. Between aluminum gratings, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4 inch thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

3.4 CLEANING AND PROTECTION

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.
- B. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055200

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Wood blocking and nailers.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
- C. Timber: Lumber of 5 inches nominal size or greater in least dimension.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated wood.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWP A U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat all rough carpentry unless otherwise indicated.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-

test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Treatment shall not promote corrosion of metal fasteners.
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- E. Application: Treat all rough carpentry unless otherwise indicated.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
- B. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1,, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.6 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
 - 2. For pressure-preservative-treated wood, use stainless-steel fasteners.
- B. Nails, Brads, and Staples: ASTM F1667.

2.7 MISCELLANEOUS MATERIALS

- A. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.
- B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- C. Provide blocking as indicated and as required to support facing materials, fixtures, specialty items, and trim.
- D. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- E. Comply with AWWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- F. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- H. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 PROTECTION

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

END OF SECTION 061000

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Glass-fiber blanket.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET

- A. Glass-Fiber Blanket, Unfaced: ASTM C665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E84; passing ASTM E136 for combustion characteristics.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Owens Corning.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft..

3.4 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse

and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Nonstaining silicone joint sealants.
 - 2. Urethane joint sealants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 FIELD CONDITIONS

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

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Engineer from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. GE Construction Sealants; Momenive Performance Materials Inc.
 - b. May National Associates, Inc.; a subsidiary of Sika Corporation.
 - c. Pecora Corporation.
 - d. Sika Corporation; Joint Sealants.
 - e. The Dow Chemical Company.

2.3 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. BASF Corporation.
 - b. Bostik, Inc.
 - c. Pecora Corporation.
 - d. Sika Corporation; Joint Sealants.
 - e. Tremco Incorporated.

2.4 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- a. BASF Corporation.
 - b. Construction Foam Products; a division of Nomaco, Inc.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. .

3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Glazed surfaces of ceramic tile.
 - d. .
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form

smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 CLEANING

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

3.5 PROTECTION

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

3.6 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces[].
 1. Joint Locations:
 - a. Tile control and expansion joints.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, M, P, 50, T, NT.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces[].
 1. Joint Locations:
 - a. Control and expansion joints in unit masonry.
 - b. Joints in glass unit masonry assemblies.
 - c. Joints between different materials listed above.
 - d. Perimeter joints between materials listed above and frames of doors and louvers.
 - e. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, S, NS, 50, NT.
 3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces[].

1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of unit masonry walls and partitions.
 - d. Other joints as indicated on Drawings.
2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: As selected by Engineer from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 081500 - FIBERGLASS REINFORCED PLASTIC DOORS AND ALUMINUM FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes fiberglass reinforced plastic (FRP) doors and aluminum frames.
- B. Related Requirements:
 - 1. Retain subparagraphs below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.
 - 2. Section 087100 "Door Hardware" for door hardware.

1.3 COORDINATION

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

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and materials thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and material thicknesses.

4. Locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of anchorages, joints, field splices, and connections.
 7. Details of accessories.
 8. Details of moldings, removable stops, and glazing.
- C. Samples: For fiberglass reinforced plastic (FRP) doors and frames with factory-applied color finishes.
1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
 - a. Provide sample which indicate gloss level.
 2. Fabrication: Prepare Samples approximately 12 by 12 inches to demonstrate compliance with requirements for quality of materials and construction:
 - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing and louvers if applicable.
 - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing hollow metal construction and glazing if applicable.
- D. Product Schedule: For fiberglass reinforced plastic (FRP) doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.
- E. Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this Section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each type of fiberglass reinforced plastic (FRP) doors and frames, for tests performed by a qualified testing agency.
- B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fiberglass reinforced plastic (FRP) doors and frames in manufacturer's original unopened packaging. Mark and remove damaged materials from the project site. Where materials are covered by a referenced specification, label the package with the specification number, type, and class, as applicable. Deliver materials in sufficient quantity to allow work to proceed without interruption.
- B. Storage:
 1. Protect materials against moisture absorption and contamination or other damage.

2. Store all materials on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer.
3. Do not store materials in buildings under construction until concrete, mortar, and plaster work is finished and dry.
4. Do not store materials outdoors.
5. Do not store materials in contact with other materials that might cause staining, denting, or other surface damage.

C. Handling:

1. Prevent damage to corners, edges and ends of materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials.

1.8 REGULATORY REQUIREMENTS

- A. Provide products, materials and assemblies, including anchorage, proposed for the work of this Section that comply with project specific calculated design pressures and the Florida Building Code, including wind-borne debris region requirements. Provide products designed by the Manufacturer and installed by the Contractor to meet these requirements.
 1. Provide products that conform to the project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Florida Building Code, the more stringent requirement shall apply.
- B. Provide documentation that the Florida Building Code compliance for the products, materials and assemblies, including anchorage specified in this Section have been incorporated into the Work. Demonstrate code compliance with the Florida Building Code, using one of the methods outlined in Chapter 9N-3 of the Florida Administrative Code, Department of Community Affairs, Florida Building Commission, Product Approval documentation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Alloy for Frames: ASTM B 221 / ASTM B 221M, alloy 6063-T5 for extrusions; ASTM B 209 / B 209M, alloy and temper best suited for aluminum sheets and strips.
- B. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- C. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Curries Company; an Assa Abloy Group company.
 - 2. Or equal products not accepted for this item.

2.3 DOORS

- A. Non-Rated Openings: Provide the following:
 - 1. Face Sheets - Seamless fiberglass reinforced polyester plastic, 0.110-in thick.
 - 2. Internal Stiles and Rails - Structural fiberglass reinforced plastic with solid polymer corner reinforcement.
 - 3. Core - Polyurethane, 1-1/2-inches thick, U factor - 0.14 deg Btu/F x h x sq. ft. .
 - 4. Hardware Reinforcement - Solid polymer.
 - 5. Intermediate Framing - Supply structural FRP as and where required for door integrity.
 - 6. Chemically weld entire door.
 - 7. Polyester gel-coat entire door following hardware machining, 15 mils plus/minus 3 mils dry film thickness.
- B. Exterior Door Model 747, Full Flush.
- C. Interior Door Model 907.

2.4 FRAMES

- A. Aluminum Framing: ASTM B 221, with alloy and temper required to suit structural and finish requirements, and not less than 0.062 inch thick.
- B. Door Frames: Extruded aluminum, reinforced for hinges, strikes, and closers.
- C. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted and mitered connections.
- D. Factory prepare aluminum frames to receive templated mortised hardware; include cutouts, reinforcements, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Section 087100 "Door Hardware."

2.5 FASTENERS

- A. Stainless steel fasteners, 300 Series as approved, shall be used for frame assembly and for all other fasteners.

2.6 PERFORMANCE REQUIREMENTS

- A. Air Infiltration: When tested in accordance with ASTM E283, air infiltration is not to exceed 0.06 cubic feet per minute per square foot of fixed area at a test pressure of 6.24 pounds per square foot at 50 mile per hour wind.
- B. Water Penetration: When tested in accordance with ASTM E331, no water penetration is allowed, at a pressure of 8 pounds per square foot of fixed area.
- C. Provisions for Thermal Movement: Design doors and frames to provide for expansion and contraction of the component parts caused by an ambient temperature range of minus 0 to 100 degrees F causing buckling, opening of joints, overstressing of fasteners, or other harmful effects.

2.7 FABRICATION

- A. FRP Doors:
 - 1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
 - 2. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
 - 3. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.
 - 4. Bottom Edge Closures: Close bottom edges of doors with end closures or channels of same material as face sheets.
- B. Aluminum Frames: Extruded aluminum shapes with contours approximately as indicated. Provide removable glass stops and glazing beads for frames accommodating fixed glass. Use countersunk stainless steel Phillips screws for exposed fastenings, and space not more than 12 inches on center. Mill joints in frame members to a hairline fit, reinforce, and secure mechanically.
 - 1. Construction: Non-thermal at interior locations; thermally broken at exterior locations.
- C. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.
- D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
 - 1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
 - 2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.8 FRP FINISH

- A. Gelcoat Matte Finish, 25 mil (smooth face sheets only), from manufacture's full range of colors

2.9 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class I, 0.018 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that wall thickness does not exceed standard tolerances allowed by throat size of indicated aluminum frame.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. Aluminum Frames: Install frame components in the longest possible lengths with no piece less than 48 inches; components 96 inches or shorter shall be one piece.
 - 1. Use concealed installation clips to produce tightly fitted and aligned splices and connections.
 - 2. Secure clips to extruded main-frame components and not to snap-in or trim members.
 - 3. Do not leave screws or other fasteners exposed to view when installation is complete.
- B. FRP Door: Fit and hang door in accordance with clearances specified below:
 - 1. Clearance Tolerances:
 - a. Jambs and Head: Plus 1/8-inch or minus 1/16-inch.
 - b. Pairs of Doors: Plus 1/8 inch or minus 1/16-inch.
 - c. Bottom of Door and Top of Threshold: Maximum (3/8-inch.
 - d. Bottom of Door and Top of finish floor (No Threshold: Maximum 3/4-inch.

3.4 ADJUSTING

- A. Inspect installation, correct misalignments, and tighten loose connections.

- B. Doors: Adjust doors to operate smoothly and easily, without binding or warping. Adjust hardware to function smoothly and lubricate as recommended by manufacturer.
- C. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended in writing by frame manufacturer and according to AAMA 609 & 610.
- D. Touch Up: Repair marred surfaces to blend inconspicuously with adjacent unrepaired surface so touchup is not visible from a distance of 48 inches as viewed by Engineer. Remove and replace doors and frames with damaged finish that cannot be satisfactorily repaired.

END OF SECTION 081500

SECTION 083483 - FLOOR DOORS (ACCESS HATCHES)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes floor doors (access hatches).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details materials, individual components and profiles, and finishes.
- B. Product Schedule: For floor doors. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 ALUMINUM FLOOR DOORS

- A. Weather-tight Surface Mounted Angle Frame Aluminum Floor Door:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Halliday Products.
 - b. U.S.F. Fabrication.
 - c. BILCO Company (The).
 - 2. Frame: Mill finish aluminum, angle profile.
 - 3. Door: Single leaf; 1/4-inch-thick, diamond-pattern mill-finish aluminum plate.
 - 4. Manufacturers' offerings for loading capacity vary; confirm availability. See the Evaluations for discussion of AASHTO H20.
 - 5. Loading Capacity: 300-lbf/sq. ft. pedestrian live load.
 - 6. Options: Safety aluminum grating panel with safety orange powder-coated finish designed to withstand loading indicated above for hatch. Grating shall be hinged with tamper-proof stainless steel bolts and shall be supplied with a positive latch to maintain unit in an upright position.

7. Hardware:

- a. Material and Finish: Type 316 stainless steel, including latch and lifting mechanism assemblies, hold-open arms, and brackets, hinges, pins, and fasteners.
- b. Hinges: Heavy-duty butt hinges with stainless-steel pins.
- c. Operating Mechanism: Adjustable counterbalancing springs, heavy-duty hold-open arm that automatically locks door open at 90 degrees, release handle with vinyl grip that allows for one-handed closure, and recessed lift handle.
- d. Latch: Stainless steel slam latch.
- e. Lock: Padlock hasp.

2.2 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- B. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- C. Aluminum Sheet: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Type 316 stainless steel.

2.3 FABRICATION

- A. General: Provide floor doors manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure floor doors to types of supports indicated.
- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For cylinder locks, furnish two keys per lock and key all locks alike.
- E. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that comes in contact with concrete.

2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Stainless-Steel Finish: Bright, cold-rolled, unpolished ASTM A480/A480M No. 2B finish.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor doors.

3.3 FIELD QUALITY CONTROL

- A. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- B. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

3.4 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083483

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.
2. Cylinders for door hardware specified in other Sections.

- B. Related Requirements:

1. Section 081500 Fiberglass Reinforced Plastic Doors and Aluminum Frames.

1.3 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- C. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 1. Conference participants shall include Installer and Owner's security consultant.

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.
- B. Door Hardware Schedule: Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
 - 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e. Fastenings and other installation information.
 - f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
 - g. Mounting locations for door hardware.
 - h. List of related door devices specified in other Sections for each door and frame.
- C. Keying Schedule: Detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of electrified door hardware.
 - 1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.
- C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- D. Field quality-control reports.

- E. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers who is available during the course of the Work to consult Contractor, Engineer, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
 - 3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:

- a. Exit Devices: Two years from date of Substantial Completion.
- b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

- A. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

2.3 SCHEDULED DOOR HARDWARE

- A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.
 - 1. Door hardware is scheduled in Part 3.

2.4 HINGES

- A. Hinges: BHMA A156.1.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Hager Companies.
 - b. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.5 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
 - 2. Deadbolts: Minimum 1-inch bolt throw.

- C. Lock Backset: 2-3/4 inches unless otherwise indicated.
- D. Lock Trim:
 - 1. Levers:
 - a. "P Lever Design," by SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
 - b. "17 (D Sparta)," by Schlage Commercial Lock Division; Allegion, plc (SCH).
 - c. "JEFFERSON - JNE," by Yale Commercial Locks and Hardware; an ASSA ABLOY Group company (YAL).
 - 2. Lockset Designs: Provide designs that match those scheduled.
- E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
 - 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
 - 2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
 - 4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

2.6 MANUAL FLUSH BOLTS

- A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

2.7 EXIT DEVICES AND AUXILIARY ITEMS

- A. Exit Devices and Auxiliary Items: BHMA A156.3.

2.8 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
 - 1. Core Type: Interchangeable.
- C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
- D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.9 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock.
 - 1. No Master Key System: Only change keys operate cylinders.
 - a. Provide three-cylinder change keys.
 - 2. Master Key System: Change keys and a master key operate cylinders.
 - a. Provide three-cylinder change keys and five master keys.
 - 3. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - b. Re-key Owner's existing master key system into new keying system.
 - 4. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."

2.10 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; aluminum unless otherwise indicated.

2.11 ACCESSORIES FOR PAIRS OF DOORS

- A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.

2.12 SURFACE CLOSERS

- A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.13 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.

2.14 DOOR GASKETING

- A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
- B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:
 - 1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.
 - 2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
 - 3. Gasketing on Double Doors: 0.50 cfm per foot of door opening.

2.15 THRESHOLDS

- A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.16 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Engineer.
 - 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
 - 1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
 - 2. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames.
 - 2) Strike plates to frames.
 - 3) Closers to doors and frames.
 - b. Steel Through Bolts: For the following unless door blocking is provided:

- 1) Surface hinges to doors.
 - 2) Closers to doors and frames.
 - 3) Surface-mounted exit devices.
3. Spacers or Hex Bolts: For through bolting of hollow-metal doors.
 4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.17 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.
- E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as directed by Owner.
 - 2. Furnish permanent cores to Owner for installation.
- F. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- G. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- H. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 1. Do not notch perimeter gasketing to install other surface-applied hardware.
- I. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- J. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
 2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
 3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

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

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

- A. HW 1 (Locked Single Door with Exit Device)

3	Hinges	BB1199, 4-1/2 x 4-1/2	US32D	Hager
1	Exit Device	ED5200S	US32D	Corbin Russwin
1	Cylinder	ML20606 NAC Series	US26D	Corbin Russwin
1	Closer	281 Series with heavy duty arm	US26D	Sargent
1	Overhead Stop and Holder:	1ADJ-026	US26D	Rixson
1	Kick Plate	K1050, stainless, 8" high 4BE	US32D	Rockwood
1	Door Bottom	314CN		Pemko
1	Threshold	2005AT		Pemko

1	Gasketing	290AV (coordinate head w/closer)		Pemko
B. HW 2 (Locked Pair of Doors with Exit Device)				
6	Hinges	BB1199, 4-1/2 x 4-1/2	US32D	Hager
1	Exit Device	ED5808 Series	US32D	Corbin Russwin
1	Flush Bolts (inactive leaf)			
1	Cylinder	1E-74 x Required Length / Cam	US26D	Corbin Russwin
2	Closer	281 Series with heavy duty arm	US26D	Sargent
2	Overhead Stop and Holder:	1ADJ-026	US26D	Rixson
2	Kick Plate	K1050, stainless, 8" high 4BE	US32D	Rockwood
2	Door Bottom	314CN		Pemko
1	Threshold	2005AT		Pemko
1	Gasketing	290AV (coordinate head w/closer)		Pemke
C. HW 3 (Privacy Toilet Room)				
3	Hinges	BB1199, 4-1/2 x 4-1/2	US32D	Hager
1	Lockset	ML2020 function - Bathroom	US32D	Corbin Russwin
1	Closer	281 Series with heavy duty arm	US26D	Sargent
1	Overhead Stop and Holder:	1ADJ-026	US26D	Rixson
1	Kick Plate	K1050, stainless, 8" high 4BE	US32D	Rockwood

END OF SECTION 087100

SECTION 089119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

- B. Windborne-debris-impact-resistance test reports.
- C. Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this Section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.6 QUALITY ASSURANCE

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

1.7 REGULATORY REQUIREMENTS

- A. Provide products, materials and assemblies, including anchorage, proposed for the work of this Section that comply with project specific calculated design pressures and the Florida Building Code, including wind-borne debris region requirements. Provide products designed by the Manufacturer and installed by the Contractor to meet these requirements.
 - 1. Provide products that conform to the project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Florida Building Code, the more stringent requirement shall apply.
- B. Provide documentation that the Florida Building Code compliance for the products, materials and assemblies, including anchorage specified in this Section have been incorporated into the Work. Demonstrate code compliance with the Florida Building Code, using one of the methods outlined in Chapter 9N-3 of the Florida Administrative Code, Department of Community Affairs, Florida Building Commission, Product Approval documentation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
 - 1. Wind Loads: Determine loads based on pressures as indicated on the Structural Drawings.
- B. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade shall pass basic-protection, large-missile testing requirements in ASTM E 1996 for Wind Zone 3 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than louvers indicated for use on Project.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- E. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Drainable-Blade Louver:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Airolite Company, LLC (The).
 - b. Greenheck Fan Corporation.
 - c. Ruskin Company.
 - 2. Louver Depth: 6 inches.
 - 3. Frame and Blade Nominal Thickness: Not less than 0.060 inch for blades and 0.080 inch for frames.
 - 4. Mullion Type: Exposed.
 - 5. Louver Performance Ratings:
 - a. Free Area: Not less than 8.5 sq. ft. for 48-inch- wide by 48-inch- high louver.
 - b. Point of Beginning Water Penetration: Not less than 1000 fpm.
 - c. Air Performance: Not more than 0.10-inch wg static pressure drop at 800-fpm free-area intake velocity.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
 4. For fastening stainless steel, use 300 series stainless-steel fasteners.
 5. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 1. Frame Type: Channel unless otherwise indicated.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide extended sills for recessed louvers.
- F. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: As selected by Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Engineer, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089119

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior partitions.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Horizontal Deflection: For composite wall assemblies, limited to 1/360 of the wall height based on horizontal loading of 10 lbf/sq. ft..

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
1. Steel Sheet Components: Comply with ASTM C645 requirements for metal unless otherwise indicated.
 2. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.
1. Steel Studs and Tracks:
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) ClarkDietrich.
 - 2) MarinoWARE.
 - b. Minimum Base-Steel Thickness: As indicated on Drawings.
 - c. Depth: As indicated on Drawings.
 2. Embossed, High-Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally equivalent to conventional ASTM C645 steel studs and tracks.
 - 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) ClarkDietrich.
 - 2) MarinoWARE.
 - b. Minimum Base-Steel Thickness: As indicated on Drawings.
 - c. Depth: As indicated on Drawings.
- C. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch- wide flanges.
- 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:
 - b. ClarkDietrich.
 - c. MarinoWARE.
 2. Depth: 1-1/2 inches.
 3. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 - 1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 - 1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
 - 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8-inch thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C754.
 - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.
- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

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

1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 2. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts that penetrate partitions above ceiling.
1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Interior gypsum board.
- 2. Tile backing panels.

- B. Related Requirements:

- 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
- 2. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.3 ACTION SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

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

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD, GENERAL

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

2.2 INTERIOR GYPSUM BOARD

- A. Abuse-Resistant Gypsum Board: ASTM C 1396/C 1396M gypsum board, tested according to ASTM C 1629/C 1629M.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Georgia-Pacific Gypsum LLC.
 - b. National Gypsum Company.
 - c. USG Corporation.
 2. Core: 1/2 inch, regular type.
 3. Surface Abrasion: ASTM C 1629/C 1629M, meets or exceeds Level 3 requirements.
 4. Indentation: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.
 5. Soft-Body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 2 requirements.
 6. Long Edges: Tapered.
 7. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.3 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or ASTM C 1325, with manufacturer's standard edges.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation.
 - b. National Gypsum Company.
 - c. USG Corporation.
 2. Thickness: 1/2 inch.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Plastic.
 - 2. Shapes:
 - a. L-Bead: L-shaped; exposed long flange receives joint compound.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
 - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
 - 4. Finish Coat: For third coat, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
 - 1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 - 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- C. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- D. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
- E. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Abuse-Resistant Type: As indicated on Drawings.
- B. Single-Layer Application:
 - 1. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

- b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

- 2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Interior Trim: Install in the following locations:
 - 1. L-Bead: Use where indicated.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 2: Panels that are substrate for tile Where indicated on Drawings Insert locations.
 - 2. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

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

- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093013 - CERAMIC TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Ceramic mosaic tile.
- 2. Glazed wall tile.

- B. Related Requirements:

- 1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
- 2. Section 092900 "Gypsum Board" for cementitious backer units.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Face Size: Actual tile size, excluding spacer lugs.
- D. Module Size: Actual tile size plus joint width indicated.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples:
 - 1. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.

2. Stone thresholds in 6-inch lengths.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer employs at least one installer for Project that has completed the Advanced Certification for Tile Installers (ACT) certification for installation of gauged porcelain tile/gauged porcelain tile panels and slabs.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.8 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.3 TILE PRODUCTS

- A. Ceramic Tile Type: Factory-mounted unglazed ceramic mosaic tile.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Olean; a division of Dal-Tile Corporation.
 - b. Daltile.
 - 2. Composition: Porcelain.
 - 3. Certification: Porcelain tile certified by the Porcelain Tile Certification Agency.
 - 4. Module Size: 2 by 2 inches.
 - 5. Thickness: 1/4 inch.
 - 6. Face: Plain with cushion edges.
 - 7. Surface: Smooth, without abrasive admixture.
 - 8. Dynamic Coefficient of Friction: Not less than 0.42.
 - 9. Finish: Mat, clear glaze.
 - 10. Tile Color and Pattern: As selected by Engineer from manufacturer's full range.
 - 11. Grout Color: As selected by Engineer from manufacturer's full range.
 - 12. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

- a. External Corners for Thinset Mortar Installations: Surface bullnose, module size 2 by 2 inches.
- b. Internal Corners: Cove, module size 1 by 1 inch.
- c. Internal Corners: Field-butt square corners. For coved base and cap, use angle pieces designed to fit with stretcher shapes.

B. Ceramic Tile Type: Glazed wall tile.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Olean; a division of Dal-Tile Corporation.
 - b. Daltile.
2. Module Size: 6 by 6 inches.
3. Face Size Variation: Rectified.
4. Thickness: 5/16-inch.
5. Face: Plain with modified square edges or cushion edges.
6. Finish: Bright, clear glaze.
7. Tile Color and Pattern: As selected by Engineer from manufacturer's full range.
8. Grout Color: As selected by Engineer from manufacturer's full range.
9. Mounting: Factory, back mounted.
10. Mounting: Pregrouted sheets of tiles are factory assembled and grouted with manufacturer's standard white silicone rubber.
11. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base for Thinset Mortar Installations: Straight, module size 6 by 6 inches.
 - b. External Corners for Thinset Mortar Installations: Surface bullnose, same size as adjoining flat tile.
 - c. Internal Corners: Field-butt square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

2.4 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bonsal American, an Oldcastle company.
 - b. LATICRETE SUPERCAP, LLC.
 - c. MAPEI Corporation.

2.5 SETTING MATERIALS

A. Standard Dry-Set Mortar (Thinset): ANSI A118.1.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bonsal American, an Oldcastle company.
 - b. Bostik, Inc.
 - c. LATICRETE SUPERCAP, LLC.
 - d. MAPEI Corporation.
2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.

B. Modified Dry-Set Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bonsal American, an Oldcastle company.
 - b. Bostik, Inc.
 - c. LATICRETE SUPERCAP, LLC.
 - d. MAPEI Corporation.
2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.6 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.

B. Standard Cement Grout: ANSI A118.6.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Bonsal American, an Oldcastle company.
 - b. Bostik, Inc.
 - c. LATICRETE SUPERCAP, LLC.
 - d. MAPEI Corporation.

2.7 MISCELLANEOUS MATERIALS

- A. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- B. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bonsal American, an Oldcastle company.
 - b. Custom Building Products.

2.8 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Engineer.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 INSTALLATION OF CERAMIC TILE

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors in wet areas.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.

2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Ceramic Mosaic Tile: 1/16 inch.
2. Glazed Wall Tile: 1/16 inch.

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

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.

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

3.4 INSTALLATION OF WATERPROOF MEMBRANE

- A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.5 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 1. Remove grout residue from tile as soon as possible.
 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Ceramic Tile Installation: TCNA F122; thinset mortar on waterproof membrane.
 - a. Thinset Mortar: Modified dry-set mortar.
 - b. Grout: High-performance unsanded grout.
- B. Interior Wall Installations, Masonry or Concrete:
 - 1. Ceramic Tile Installation: TCNA W202; thinset mortar.
 - a. Thinset Mortar: Standard dry-set mortar.
 - b. Grout: Standard sanded cement grout.
- C. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. Ceramic Tile Installation: TCNA W221 and ANSI A108.1A; cement mortar bed (thickset) over waterproof membrane on solid backing.
 - a. Bond Coat for Cured-Bed Method: Standard dry-set mortar.
 - b. Grout: Standard sanded cement grout.

END OF SECTION 093013

SECTION 099010 - SHOP PRIMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes shop primers not included in other sections.
- B. Related Requirements:
 - 1. Division 09 for field applied painting.
 - 2. Other specifications that reference this specification for primers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include written statement, or published product data, that the confirms that the shop primer materials are compatible with the finish and field coatings.
- B. Samples: For each exposed product.

1.4 QUALITY ASSURANCE

- A. Compatibility of Coating Systems - Shop priming with primers that are guaranteed, in writing, by the manufacturer to be compatible with field applied and other coatings.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Submerged Surfaces - Shop primer for ferrous metals which will be in contact with water being treated, either submerged or which are subject to splash action or which are specified to be considered submerged service:
 - 1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer):
 - a. TNEMEC: Series 1 Omnithane.
 - b. Carboline: Carboguard 561.

- c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
 - d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amerlock 400.
 - e. Or equal.
- B. Non-Submerged Surfaces: Shop primer for ferrous metals which will not be in contact with water being treated, not submerged and not subject to splash action:
 - 1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer):
 - a. TNEMEC: Series 1 Omnithane.
 - b. Carboline: Carboguard 561.
 - c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
 - d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amercoat 68HS.
 - e. Or equal.
- C. Submerged Surfaces:
 - 1. Shop Prime Coat for Ductile Iron Pipe: (Epoxy, Polyamidoamine Shop Primer):
 - a. TNEMEC: Series N140 Pota-Pox-Plus.
 - b. Carboline: Carboguard 561.
 - c. Sherwin-Williams Company (The): Macropoxy 846 NSF Winter Grade Epoxy Mill White.
 - d. PPG PMC Aquapon HB Potable Water Epoxy Coating 95-132 Series or PPG PMC Amerlock 2 Epoxy.
 - e. Or equal.
 - 2. Shop Prime Coat for Ferrous Metal Surfaces: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer):
 - a. TNEMEC: Series 1 Omnithane.
 - b. Carboline: Carboguard 561.
 - c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
 - d. PPG PMC Durathane MCZ 97-679 Series.
 - e. Or equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface preparation: Comply with the manufacturer's written requirements for the substrate to be primed.

3.2 PROTECTION

- A. Non-Primed Surfaces – Apply a heavy shop coat of grease or other suitable rust-resistant coating to gears, bearings surfaces and other similar surfaces which are not to be field painted.
 - 1. Maintain this coating to prevent corrosion until final acceptance testing of equipment.

END OF SECTION 099010

SECTION 099100 – PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following substrates:
 - 1. Concrete.
 - 2. Concrete masonry units (CMUs).
 - 3. Steel and iron.
 - 4. Galvanized metal.
 - 5. Portland cement plaster (stucco).
 - 6. Gypsum board.
- B. Section includes painting all exposed structural and miscellaneous steel; chemical tanks and systems; mechanical and electrical equipment; sluice gates, operators and posts; conveying systems, pipe, fittings and valves; electrical conduit and appurtenances; new CMU walls; exposed interior ducts; all as specified in the attached painting schedules and all other work obviously required to be painted unless otherwise specified. Minor items not mentioned in the schedule of work shall be included in the work of this Section where they come within the general intent of this Section as stated herein.
- C. Aluminized steel, above roof level, for stacks: Paint with silicone aluminum as specified. Other aluminum-paint only where noted (as is specified).
- D. Paint items noted in "Painting Schedule."
- E. Provide vinyl film letters and numbers for markings as specified.
- F. Paint items noted in other Specification Sections as having factory finish and other factory finished items are obviously not field painted.
- G. Paint all factory finish painted items replaced, repaired or damaged during construction.
- H. The various Sections are responsible, as stated in each, for preparation and field touch-up of abrasions, welds and damaged primed areas of primed or galvanized components after erection.
- I. The following items will not be painted:
 - 1. Concrete except where specified above and scheduled to be painted and seamless flooring.

2. Stainless steel louvers, doors and frames.
3. Finish hardware.
4. Non-ferrous metals and stainless steel, unless specifically noted otherwise.
5. Factory pre-finished architectural components.
6. Packing glands and other adjustable parts and name plates of mechanical equipment.
7. Parts of buildings not exposed to sight, unless specifically noted otherwise.
8. Maintenance equipment
9. Plumbing fixtures.
10. Mechanical, HVAC, Plumbing and Electrical equipment which has been finished painted in the factory as specified in Divisions [22, 23, 26, 41, 42, 43, 44, 46 and 48].

J. Related Requirements:

1. Valve identification is included in Divisions 11, 22, 23, 41, 42, 43, 44, 46 and 48.
2. Shop priming of equipment and piping (except copper piping) are specified in Section 099110 – Shop Priming and included in the respective Section with the item to be primed.
3. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Indicate VOC content.

B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 QUALITY ASSURANCE

A. Shop Primers, specified in Section 099100 "Shop Primers," and other Sections are required to be certified by the manufacturer of the field applied painting manufacturer to be compatible with the materials specified in this section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products by one of the following:
 - 1. Tnemec, Inc.(TN);
 - 2. The Sherwin Williams Company (SW)
 - 3. PPG Architectural Finishes, Inc. (PPG)
 - 4. PPG Architectural Finishes, Inc. Ameron (AME)
 - 5. Or equal.

2.2 MATERIALS

- A. Material Compatibility:
 - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. Provide products of same manufacturer for each coat in a coating system.
- B. Use paint materials without adulteration and mixed, thinned and applied in strict accordance with manufacturer's directions for the applicable materials and surface.
- C. Colors: As selected by Engineer from manufacturer's full range.

2.3 COLOR CODING FOR PIPES AND EQUIPMENT

- A. The color code establishes, defines and assigns a definite color for each process system. Paint all elements which are an integral part of the system, that is originating from the equipment and/or supplying the equipment, between and up to but not including the fixed flanges nor the flexible conduit connections on the equipment. Paint valves and fittings in the color of the main body of the pipe.
- B. All pipes and equipment shall be painted with final coat color selected by the Engineer and shall be treated as an integral part of the Contract.
- C. All hanger saddles and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. Hanger rods and hanger rod connections to building structure shall be painted to match the color of the wall or ceiling to which it is attached.

2.4 LETTERING OF TITLES

- A. Indicate the name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of fluids on each pipe system. Locate the titles shall not more than 26 feet apart and directly adjacent to each side of any wall the pipeline breaches, adjacent to each side of the valve regulator, flowcheck, strainer cleanout and all pieces of equipment.
- B. Identify titles by the identity of the contents with complete name at least once in each space through which it passes and thereafter by generally recognized abbreviations, letters or numerals as approved. Place identification title locations in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title to be clearly visible from operating positions and adjacent to all control valves.
- C. Die cut numbers and letters from 3.5 mil vinyl film and pre-space them on carrier tape. Protect adhesive and finish surface with one piece removable liners. Use white or black to provide high contrast to the substrate color.
- D. Letter size shall be as indicated in the following table:

OUTSIDE DIAMETER OF PIPE OR COVERING	SIZE OF LEGEND LETTERS
3/4-in to 1-1/4-in	1/2-in
1-1/2-in to 2-in	3/4-in
2-1/2-in to 6-in	1-1/2-in
8-in to 10-in	2-1/2-in
Over 10-in	3-in

- E. Use Type B ASI/2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Provide Optima Bold, upper case letter type. Use Grid 2 spacing. Match arrow to letter type and size. Follow the instructions of the manufacturer in respect to storage, surface preparation and applications of letters.

2.5 TITLES FOR EQUIPMENT

- A. Provide titles consisting of vinyl film as specified above on all equipment using 1-in high Optima Bold upper case, Grid 2 spacing. Use white or black to provide high contrast to the substrate color. Use titles shown on mechanical drawings for bidding purposes. Mount titles at eye level on machines or at the upper most broad vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, number the items consecutively as indicated on the mechanical drawings or as directed by the Engineer; for example, Pump No. 1, Pump No. 2, etc. Titles shall be composed in more than one line if required and justified on the left-hand side.

2.6 TESTING EQUIPMENT

- A. Furnish wet and dry film thickness gauges, electronic moisture meter and all other equipment required by the Engineer for inspection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
 - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
 - b. Masonry (Clay and CMU): 12 percent.
 - c. Gypsum Board: 12 percent.
- B. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer[.] [**but not less than the following:**]
 - 1. SSPC-SP 2.
 - 2. SSPC-SP 3.
 - 3. SSPC-SP 7/NACE No. 4.
 - 4. SSPC-SP 11.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Aluminum Substrates: Remove loose surface oxidation.
- J. Wood Substrates:
 - 1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- K. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Paint entire exposed surface of window frames and sashes.
 - 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view:
 - a. Uninsulated metal piping.
 - b. Uninsulated plastic piping.
 - c. Pipe hangers and supports.
 - d. Metal conduit.
 - e. Plastic conduit.
 - f. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Engineer, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 PAINTING SCHEDULE

- A. Dry Film Thickness (DFT) for each paint product is not part of paint schedule. Submit both the Wet Film Thickness (WFT) and DFT for each product as part of submittal process. Apply paint and coating products to comply with manufacturer's DFT thickness and application recommendations in the approved submittal.

3.7 The following types of paints by Tnemec Co. (TN), The Sherwin Williams Company (SW), PPG Protective & Marine Coatings, (PPG), and Ameron International (AME) have been used as a basis for the paint schedule; use one of these paints or equal:

A. Epoxy:

1. TN:Hi-build Epoxoline II, Series N69.
2. SW: Macropoxy 646, B58 Series.
3. PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
4. AME: Amerlock 2/400 Series Epoxy.

B. Waterborne Cementitious Acrylic: Result in pinhole free surface.

1. TN:Envirofil, Series 130-6602.
2. SW: Cement-Plex 875, B42 Series.
3. PPG: Cementitious Waterproofing Block Filler 95-217 Series.
4. AME: Amerlock 400 BF Epoxy Block Filler.

C. High-Build Acrylic Polyurethane Enamel:

1. TN:Endura-Shield - semi-gloss, Series V73.
2. SW: Acrolon 218 HS, B65 Series.
3. PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
4. AME: Amercoat 450HSG Polyurethane.

D. High Heat Silicone Aluminum (to 600 degrees F):

1. TN:No product.
2. SW: Heat-Flex Hi-Temp 1000 Aluminum, B59-820 Series.
3. PPG: Speedhide 6-220 Series Silicone Aluminum Coating.
4. AME: Amercoat 878 Silicone Aluminum Coating.

E. Tie Coat, Low VOC, Epoxy:

1. TN:FC Typoxy, Series V27.
2. SW: Macropoxy 646, B58 Series.
3. PPG: Pitt-Guard Epoxy Mastic 95-245 Series.
4. AME: Amercoat 385 Multi-Purpose Epoxy.

F. Acrylic Latex Emulsion, Eggshell Finish:

1. TN:Tneme-Cryl, Series 6.
2. SW: DTM Primer/Finish, B66 Series.

3. PPG: Pitt-Tech Plus 90-1110 Series Satin DTM Acrylic.
4. AME: Amercoat 220 Waterborne Acrylic.

G. Vinyl Acrylic Surface Sealer:

1. TN:PVA Sealer, Series 51.
2. SW: Prep-Rite 200 Primer, B28 Series.
3. PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
4. AME: Amercoat 148 Acrylic Primer.

H. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat as recommended by manufacturer:

1. Exterior non- submerged ferrous metals (except first coat-hollow metal-pressed metal work):
 - a. First Coat: On properly prepared unprimed metal or for touch-up:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
 - b. Second Coat:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
 - c. Third Coat:
 - 1) TN: Endura-Shield - semi-gloss, Series V73.
 - 2) SW: Acrolon 218 HS, B65 Series.
 - 3) PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
 - 4) AME: Amercoat 450HSG Polyurethane.
2. Interior non-submerged concrete scheduled for painting:
 - a. First and Second Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
3. Interior concrete masonry units:
 - a. First Coat: Result in pinhole free surface.
 - 1) TN: No. 130-6602.
 - 2) SW: Cement-Plex 875, B42 Series.

- 3) PPG: Cementitious Waterproofing Block Filler 95-217 Series.
 - 4) AME: Amerlock 400 BF Epoxy Block Filler.
 - b. Second and Third Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
4. Interior non-submerged ferrous metals (except first coat of previously painted metal work), on properly prepared unprimed metal or for touch-up:
 - a. First Coat:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
 - b. Second and Third Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) PPG: Amerlock 2/400 Series Epoxy.
5. Submerged ferrous metals and ferrous metals subject to submersion or splashing. Surface shall be lightly sanded or abraded before application of first field coat.
 - a. First and Second Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) PPG: Amerlock 2/400 Series Epoxy.
6. Plastic piping and, where scheduled to be painted, plastic components:
 - a. First and Second Coats:
 - 1) TN: Hi-build Epoxoline II, Series N69.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
7. Previously painted existing concrete/CMU scheduled for painting:
 - a. First Coat:
 - 1) TN: H.B. Tneme-Tufcoat, Series 113.
 - 2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.

- 3) PPG: Aquapon WB Epoxy 98-1 Series.
 - 4) AME: Amercoat 335 WB Epoxy.
 - b. Second Coat:
 - 1) TN: Enviro-Glaze, Series 297.
 - 2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
 - 3) PPG: Aquapon WB Epoxy 98-1 Series.
 - 4) AME: Amercoat 335 WB Epoxy.
8. Existing precast concrete plank ceilings scheduled to be painted.
 - a. First and Second Coats:
 - 1) TN: H.B. Tneme-Tufcoat, Series 113.
 - 2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
 - 3) PPG: Aquapon WB Epoxy 98-1 Series.
 - 4) AME: Amercoat 335 WB Epoxy.
9. Previously Painted Metal Surfaces:
 - a. First coat on substrates prepared as approved and replacing first coat of above-specified systems. Complete painting with remainder of specified system for each type of substrate.
 - b. First Coat:
 - 1) TN: FC Typoxy, Series V27.
 - 2) SW: Macropoxy 646, B58 Series.
 - 3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
 - 4) AME: Amerlock 2/400 Series Epoxy.
10. Gypsum Work:
 - a. First Coat:
 - 1) TN: PVA Sealer No. 51-792.
 - 2) SW: PrepRite 200 Primer, B28 Series.
 - 3) PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
 - 4) AME: Amercoat 148 Acrylic Primer.
 - b. Second and Third Coats:
 - 1) TN: Tneme-Cryl Series 6.
 - 2) SW: DTM Primer/Finish, B66 Series.
 - 3) PPG: Pitt-tech Plus 90-1110 Series Satin DTM Acrylic.
 - 4) AME: Amercoat 220 Waterborne Acrylic.

END OF SECTION 099100

SECTION 099724 - HIGH-PERFORMANCE CONCRETE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. JEA Water & Wastewater Standards (latest edition), Section 447.

1.2 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals required to prepare the concrete and to supply and install corrosion resistant coating on all new interior concrete surfaces where indicated on the Drawings. Corrosion resistant coating shall be applied to only interior concrete.
- B. Corrosion-resistant polymer coating shall be formulated and installed to protect concrete surfaces from corrosion.
- C. The surfaces to be coated will be exposed to H₂S, humidity, water, other components of raw sewage and sludge, and the corrosive by-products formed above the water level.
- D. Corrosion resistant coating shall be applied when structures are in the dry condition.
- E. Related Requirements:
 - 1. Section 013300 "Submittal Procedures."
 - 2. Section 018819 "Tightness Testing Performance Requirements."
 - 3. Section 030100.61 "Concrete Repairs."
 - 4. Section 030130.71 "Modifications to Existing Concrete."
 - 5. Section 033000 "Cast-in-Place Concrete."

1.3 ACTION SUBMITTALS

- A. Submit, in accordance with Section 013300 "Submittal Procedures", complete detailed shop drawings and a coating schedule for all materials furnished under this Section including the following:
 - 1. Manufacturer's current printed recommendations and product data sheets for all coating system products supplied under this Section including manufacturers printed performance criteria, surface preparation and application requirements and procedures, volatile organic compound data, and safety requirements.
 - 2. Manufacturer's termination and discontinuity details (joints, penetrations, metal embeds, wall/slab interface, corners, etc.)
 - 3. Safety Data Sheets (SDS) for any materials brought on-site including all resurfacing system materials, solvents, and abrasive blast media.

4. Storage requirements including temperature, humidity, and ventilation for coating system materials.
 5. Manufacturer's requirements, including application and safety procedures for coating system materials.
- B. Corrosion Resistant Coating Manufacturer's written instructions and drawing details for treatment of coating materials at terminations in the structures to be coated including: pipe penetrations, metal embedments, gate frames, and other terminations to be determined from the Contract Drawings. This information shall also include detail treatment for the corrosion resistant coating system at all joints in the concrete.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Product Certificates: Notarized certificate for coating system stating that product meets requirements of this Section.

1.5 QUALITY ASSURANCE

- A. The manufacturer of the coating shall furnish an affidavit attesting to the successful use of its material as a coating for concrete structures for a minimum period of 5 years in wastewater headspace conditions recognized as severe due to biogenic sulfide corrosion or otherwise detrimental to concrete and certifying that submitted products are suitable for application on the surfaces and for the service conditions. The affidavit shall also document verification by the manufacturer of the corrosion resistant coating system of the subcontractor's qualification as an approved installer of the specified coating materials and verify that the personnel who will perform this work have been trained to the satisfaction of the selected manufacturer. This affidavit shall also list the application personnel who will work on the corrosion resistant coating installation covered by this Section. The names of the tradespersons performing surface preparation, clean-up, and other miscellaneous labor functions will not have to be listed on the affidavit.
- B. The coating system shall be applied by a qualified applicator trained in handling, mixing and application of the material including the required surface cleaning and preparation. A list of at least five references of projects using the specified coating system shall be provided to the Engineer for review. These references shall include contact names and telephone numbers such that their references can be verified.
- C. Field quality control inspection and testing of the coating work will be provided by the Contractor in accordance with Part 3 of this Section.
- D. The Contractor shall not use or retain contaminated, outdated, or diluted materials for resurfacing. All materials used shall be from new containers not previously opened.
- E. The manufacturer's requirements, including application procedures and safety procedures shall be followed in detail and strictly adhered to at all times when the work is in progress.

- F. The Contractor shall use only products of the approved manufacturer and shall use products of only one manufacturer in any one system.
- G. The Contractor shall make available all locations and phases of the work for access by the Engineer or other personnel designated by the Engineer. The Contractor shall provide ventilation and egress to safely access the coating work.
- H. The Contractor shall conduct his/her work such that the coating system is installed as specified herein and as recommended by the coating system manufacturer. Any nonconforming coating system work shall be corrected as specified herein or as recommended by the manufacturer at no additional cost to the Owner.
- I. The Contractor is ultimately responsible for the workmanship and quality of the coating installation. Inspections by the Coating Manufacturer, the Engineer, or others does not limit the Contractor's responsibility for the quality of the coating work.
- J. If any requirements of this specification are contradicted by a referenced standard or vice-versa, the matter shall be resolved in writing by the Engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver all materials to the site in their original, unopened containers. Each container shall bear the manufacturer's name and label.
- B. Materials shall be stored in accordance with manufacturer's recommendations in enclosed structures and shall be protected from weather and adverse temperature conditions. Flammable materials shall be stored in accordance with state and local codes. Materials exceeding storage life as defined by the manufacturer shall be removed promptly from the site.
- C. Mix all materials in an enclosed mixing area to protect the mixing operation and materials from direct sunlight, inclement weather, freezing, or other means of damage or contamination.

1.7 FIELD CONDITIONS

- A. The field conditions shall be as indicated in this section unless otherwise allowed by the coating manufacturer and approved in writing by the Engineer.
- B. Apply coatings only when ambient air temperature is between 65 and 95 deg F.
- C. Do not apply coatings when relative humidity exceeds 90 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- D. Substrate surface temperature - 50°F minimum, and at least 10°F higher than dew point temperature.
- E. No dust generation shall be allowed during this period.
- F. Concrete pH shall be between 9.0 and 11.5 and as recommended by the high-performance coating manufacturer.

1.8 WARRANTY

- A. The Manufacturer warrants that the product and installation meet that quality and technical standards published in their current literature and be free from defects, including adhesion, bubbling, deterioration or failure of coating for a period of 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE CONCRETE COATING

A. Composition

- 1. The material used in the coating shall be a combination of powder, liquid and hardener that must be mixed together as used, specially compounded to protect concrete surfaces from biogenic sulfide corrosion.

B. Physical Properties are as follows:

- 1. All cured corrosion-resistant polymer/epoxy coating shall be free of cracks, pinholes or other defects adversely affecting the protective characteristics of the material. The Engineer may authorize the repair of such defects by approved methods.
- 2. The coating shall have good impact resistance and shall have sufficient elongation to bridge existing static hairline cracks (those which do not see thermal movement) in the concrete.
- 3. The coating shall be repairable at any time during the life of the structure.
- 4. Special Safety and Handling:

- a. There are no special safety of handling procedures.

C.

- C. The specified products for the filling of all bugholes and voids up to ½ inch in depth or resurfacing the concrete prior to lining application shall be as follows:

- 1. For Corrocoat, per manufacturer recommendation to meet warranty requirements in Section 1.7.
- 2. For Sherwin Williams Company, per manufacturer recommendation to meet warranty requirements in Section 1.7.
- 3. For PPG Industries, per manufacturer recommendation to meet warranty requirements in Section 1.7.
- 4. MortarClad Series 218 by Tnemec Company.

- D. The specified products for resurfacing concrete and the filling of all bugholes and voids in the concrete deeper than ½ inch shall be as follows:

- 1. For Corrocoat, per manufacturer recommendation to meet warranty requirements in Section 1.7.
- 2. For Sherwin Williams Company, per manufacturer recommendation to meet warranty requirements in Section 1.7.

3. For PPG Industries, per manufacturer recommendation to meet warranty requirements in Section 1.7.
 4. MortarCrete Series 217 by Tnemec Company.
- E. The specified products for the lining system shall be as follows:
1. Lining system by Corrocoat.
 2. Lining system by Sherwin Williams Company.
 3. Lining system by PPG Industries.
 4. Perma-Shield H2S Series 434 and Perma-Glaze Series G435 by Tnemec Company.

PART 3 - EXECUTION

3.1 HOISTING, SCAFFOLDING, STAGING AND PLANKING

- A. Provide, set-up, and maintain all required scaffolds, and staging and planking, and perform all hoisting work required to complete the work of this Section as indicated and specified.
- B. Scaffolds shall have solid backs and floors to prevent dropping materials therefrom to the floors or ground.

3.2 GENERAL

- A. Thinners or cleaning solvents used shall be approved by the coating manufacturer.
- B. Strictly follow the coating manufacturer's written instructions and the requirements of this specification regarding all aspects of protective coating work including: mixing, application, recoat times and curing.
- C. Environmental Requirements:
 1. Comply with the coating manufacturer's recommendations as to environmental conditions under which coating materials can be applied.
 2. Do not apply coating materials when dust is being generated.
 3. Provide all temporary lighting during the work equivalent to one 200 watt explosion proof incandescent lamp per 100 square feet of work area.

3.3 CONTROL OF AMBIENT CONDITIONS IN STRUCTURES TO BE COATED

- A. Control ambient conditions in the structures to be coated, and provide protective enclosures during surface preparation, application, and curing, to meet the specified conditions. This control work shall be continued throughout the coating system installation and curing.
- B. The minimum ambient condition requirements inside the structures for coating system work shall be as follows:

1. During all phases of coating system installation and curing:
 - a. Air temperature - 65°F minimum
 - b. Relative humidity - below 90%
 - c. Substrate surface temperature - 50°F minimum, and at least 10°F higher than dew point temperature
 - d. No dust generation
- C. Contractor shall provide ventilation and isolation of each structure to be coated. Contractor shall provide all means necessary to exhaust noxious gases and odors, which may be present during the work.

3.4 SURFACE PREPARATION

- A. Comply with initial cleaning and surface preparation, as specified herein, and manufacturer's written instructions and recommendations applicable to substrates and coating systems indicated.
- B. Surface Preparation of New Concrete Substrates
 1. Abrasive blast clean or hydro blast clean all new or repaired concrete surfaces to remove all degraded or loose concrete, and to produce a sound, clean substrate free of laitance, surface contaminants, loose materials, or otherwise deleterious substances. Cleaning shall be in accordance with SSPC-SP-13/NACE.
 2. Cleaning of new concrete surfaces must produce a minimum, uniform substrate anchor pattern or surface profile between CSP 6 and 7 in accordance with ICRI 310.2.
 3. Cleaning of repaired concrete surfaces, after proper cure of resurfacing mortars, must produce a minimum, uniform substrate anchor pattern or surface profile between CSP 4 and 5 in accordance with ICRI 310.2.
 4. Should cleaning not remove degraded or loose concrete, chipping or other abrading tools shall be used to remove the deteriorated concrete until a sound, clean substrate is achieved which is free of calcium sulfate, loose coarse or fine aggregate, laitance, loose hydrated cement paste, and otherwise deleterious substances. Abrasive blast cleaning and any other means necessary shall be used to open up all air voids or "bugholes" to expose their complete perimeter and depth. Leaving shelled over, hidden air voids beneath the exposed concrete surface will not be acceptable. Concrete substrate shall be dry prior to the application of any surface filler or coating materials.
 5. All new concrete to be coated shall have achieved a minimum of 28 days of cure time prior to coating application.
 6. New concrete surfaces shall not have been cured using curing compounds, but rather will have been wet cured.
 7. Acceptable surface preparation must produce a concrete surface pH of 9.0 to 11.5 to be confirmed by surface pH testing as specified under PART 3. Acceptable surface preparation must remove all concrete acid reaction materials. Prior to application of resurfacing mortar, test pH of concrete surfaces in accordance with ASTM F710, minimum 6 locations per surface. Submit results to engineer for review and determine if additional concrete removal is required.
 8. Following inspection of the concrete surface preparation by the Contractor, and Independent Inspection Agency and acceptance by the Engineer, thoroughly vacuum clean all concrete surfaces to be coated to remove all loose dust, dirt, and spent abrasive

leaving a dust free, sound concrete substrate. All debris produced by blast cleaning shall be removed from the structures to be coated and disposed of by the Contractor at an approved location in accordance with all applicable local, state, and federal regulations. Inspect again and if specified conditions are met, the Engineer will accept the substrate prior to commencement of coating installation. Blow down cleaning with compressed air will not be acceptable.

C. Surface Preparation of Bare and Coated Metal Substrates Onto Which Lining System Will Terminate

1. The approved lining system for concrete will terminate onto metal substrates at various transitions, embedments and penetrations. Abrasive blast clean all such surfaces to remove all dirt corrosion products, and other substances that would prevent the specified coating adhesion from being achieved. All ferrous metal surfaces (not ductile iron) shall be blast cleaned to a Near White Blast in accordance with SSPC-SP-10. All metal surfaces shall be cleaned to produce a minimum surface profile of 4.0 mils which is uniform.
2. Post Blast Cleaning: Once abrasive blast cleaning has been accepted, proceed as follows:
 - a. Remove all traces of grit, dust, dirt, rust scale, friable material, loose corrosion products or embedded abrasives from substrate by vacuum cleaning prior to coating system application.
 - b. Prevent contamination of the concrete or metal surfaces after blasting from workers' fingerprints, deleterious substances on workers' clothing, or from atmospheric conditions. If, after cleaning, contamination occurs, reblast and reclean to achieve specified substrate cleanliness. Care must be taken to hold the specified degree of cleanliness on metal surfaces to prevent rust bloom prior to proceeding with application of the coating materials.

3.5 INSTALLATION OF COATING SYSTEM

- A. Unless specified elsewhere herein, strictly comply with the coating manufacturer's most recent written instructions with respect to the following:
1. Mixing of All Materials.
 2. Protection and Handling of All Materials.
 3. Recoat Limitation and Cure Times.
 4. Minimum Ambient and Substrate Temperatures, Substrate's Degree of Dryness, Relative Humidity and Dew Point of Air.
 5. Application.
 6. Final Curing.
 7. Use of Proper Application Equipment.
- B. The protective coating shall provide sealed substrates to prevent penetration of H₂S gas and liquids.
- C. Repair all voids or damaged areas of the concrete substrates to be lined using the specified trowel applied repair materials recommended by the manufacturer to provide "bughole" free surfaces for the corrosion resistant coating.
- D. Uniformly apply coatings at spreading rate required to achieve minimum 125 mil DFT.

- E. Provide coating system terminations at leading edges (above or below the water line) and at all metallic interruptions to the concrete substrate, i.e. pipe supports, pipe penetrations, gates to adjacent structures, tanks, and channels, etc. Treat terminations in accordance with the termination details and instructions provided by the coating manufacturer.
- F. Treat coating application at joints or cracks in accordance with the drawing details or written instructions provided by the coating manufacturer.

3.6 CURING OF PROTECTIVE COATING SYSTEM

- A. Protected finish coating from damage during curing as recommended by the coating manufacturer. Ambient conditions shall be controlled during curing to ensure the minimum air temperature and minimum relative humidity as required by the coating manufacturer.

3.7 CLEAN-UP

- A. At the completion of the coating installation work, remove all equipment, surplus material, and debris from the site. The surrounding surface area, including roadways, and all other surfaces shall be restored to their pre-project condition.

3.8 FIELD QUALITY CONTROL INSPECTION AND TESTING

- A. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems. Manufacturer's representative shall hold point inspections to review surface preparation prior to application of coating.
- B. Contractor or Contractor's representative shall perform the procedures listed below in conjunction with the requirements of this Section and prepare daily inspection reports documenting all required Q.C. inspection and test findings. The inspector will inspect the work to determine conformance to the contract documents.
- C. Inspect and record substrate profile (anchor pattern) requirements visual inspection and comparison to ICRI 310.2 CSP Replicas for concrete substrates. Perform profile comparison for concrete once for every 100 sq. ft. of surface area to be lined.
- D. Measure and record ambient air temperature once every two hours of each shift using a thermometer and measure and record substrate temperature once every two hours using a surface thermometer.
- E. Measure and record relative humidity every two hours of each shift using a sling psychrometer in accordance with ASTM E337.
- F. Check for the presence of substrate moisture in the concrete by performing the Standard Test method for Indicating Moisture in Concrete by the Plastic Sheet Method in accordance with ASTM D4263. If the presence of moisture is indicated, take measures to force dry the concrete substrate prior to commencing with coating system application. Force drying can be accomplished using indirect heaters and fans. If the source of substrate moisture cannot be

eliminated by force drying, the Contractor shall consult with the Engineer. Perform this test once for every 200 sq. ft. of area to be coated and more frequently at darkened concrete areas.

- G. Confirm correct mixing of coating materials as specified herein.
- H. Inspect and record that the "pot life" of coating materials is not exceeded during installation.
- I. Provide and record adhesion of the coating materials in accordance with ASTM D7234. Testing shall be performed at one location for every 200 sq. ft. of surface area to be coated. Use the following procedure:
 - 1. Clean the coating surface to remove all oil, dirt, dust or other contaminants.
 - 2. Cut through the coating material into the substrate using a circular core drill in accordance with the pertinent standard requirements.
 - 3. Mix and apply rapid setting two component epoxy adhesive onto the abrasive blast cleaned disk or load fixture. Install the disk or load fixture firmly over the cut out circular area and hold in place using tape or other means to secure it until adhesive has cured.
 - 4. Remove the disk or load fixture with the Pull Off Testing instrument, strictly following the instrument manufacturer's instructions.
 - 5. Read or calculate the adhesive tensile pull value and record in pounds per square inch (psi). The adhesive tensile pull value must exceed 300 psi and must remove concrete over 90% of the load fixture surface that is attached to the underside of the disk or load fixture. If it does not, two additional adhesion tests will be performed in the same 200 sq. ft. area. If the requirements set forth above are still not met, the coating installation in this area will be deemed unacceptable and shall be removed and reinstalled immediately until acceptable adhesion is achieved (at no additional cost to the Owner). All test locations are to be repaired by the Contractor to achieve a pinhole free coating directly following acceptable results at no additional cost to the Owner.
- J. Measure and record the thickness of the coating system using the following methods:
 - 1. Use notched gauge in accordance with ASTM D4414 for Wet Film Thickness at least once every 50 sq. ft. of coating area. (For metal and resurfaced concrete substrates.)
 - 2. Following cure, the coating shall be tested for dry film thickness once for every 500 sq. ft. of surface area using a Positector 100 DFT Gauge calibrated in accordance with the instrument manufacturer's instructions. Any areas found to be below 125 mils DFT above filled bugholes and above the prepared substrate profile shall receive an additional application of the coating or shall be removed/recoated as required to meet the total DFT requirement at no additional cost to the Owner. Additional thickness may be problematic in areas where mechanical moving equipment tolerances are critical. At such locations, coating removal and reapplication to the specified film thickness may be required, at no additional cost to the Owner.
- K. All coating surfaces shall be visually inspected for areas showing poor adhesion, air inclusion, edges or seam defects or any other defects in the coating preventing a complete seal of the surfaces to be protected. Any and all deficiencies or defective work (not in compliance with this Section or related Sections) will be marked by the inspector for repairs or removal/replacement by the Contractor at no additional cost to the Owner.

L. Holiday and Pinhole Testing

1. Location of holidays and pinholes in the coating shall be performed in the field using spark testing. Upon completion of the coating installation, thoroughly dry and clean the surface of the coating and conduct visual inspection and holiday testing. All areas of the coating failing to meet the field test shall be repaired and retested. The spark testing shall be done with a Tinker & Rasor Holiday Detector (Model AP-W). This testing must be performed in accordance with ASTM D4787, using the revised procedure that follows:
2. Trial Holiday Detection-Drill a 1/16 inch diameter hole through the coating into the concrete 100 feet away from the ground connection. Follow ASTM D4787 Section 12 for adjusting the voltage setting for the 1/8 inch thick lining. Generally, the setting should total 100 volts per mil of thickness. Adjust the voltage +/- 5% to the established setting and pass the electrode over the known holiday to ensure detection at this distance from ground and at the recommended voltage setting. If detected, proceed by moving the electrode over the coating surface slowly (approximately 1/2 to 1 foot per second) and mark holiday for repair as they are detected. If the known holiday is not detected, proceed as follows:
 - a. Check cleanliness (shiny metal clean) of ground connection and repeat detection of known holiday.
 - b. Check battery power charge for instrument.
 - c. Try a new ground location and repeat detection of known holiday.
 - d. Gradually increase the instrument voltage until the known holiday can be detected and check the coating thickness at this location. The rule for voltage settings is 100 volts per mil of coating thickness.
 - e. The voltage setting should follow the rule of 100 volts per mil of coating thickness.
3. Marking of Holidays
 - a. Holidays are to be marked on the coating using felt tipped pens or other markers approved by the coating material manufacturer. Holidays are to be repaired in strict accordance with the lining manufacturer's recommendation, at no additional cost to the Owner. Holiday detection is to be repeated only over the coating repair locations.

M. Final Inspection

1. Perform a final inspection to determine whether coating work meets the requirements of the specifications. This work shall be performed by the Engineer, the Independent Inspection Agency and the Contractor.
2. Mark any rework required on any pinholes, holidays or any other inadequacies in the quality of the coating work. Such areas shall be recleaned and repaired by the Contractor as specified herein at no additional cost to the Owner.

END OF SECTION 099724

SECTION 102800 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Under-lavatory guards.
- B. Related Requirements:
 - 1. Section 093013 "Ceramic Tiling" for ceramic toilet and bath accessories.

1.3 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain public-use washroom accessories from single source from single manufacturer.
- B. Toilet Tissue (Roll) Dispenser:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Tork Twin Jumbo Bath Tissue Roll Dispenser.
 - 1) Model: 247549A.
 - 2) Color: Black.
 - b. Or Equal product not acceptable for this item.
- C. Paper Towel (Roll) Dispenser:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Tork Elevation Matic Hand Towel Roll Dispenser.
 - 1) Model: 5510282.
 - 2) Color: Black.
 - b. Or Equal product not acceptable for this item.

D. Waste Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Bobrick Washroom Equipment, Inc.
 - 1) Model: B-2260.
 - 2) Material: Stainless Steel.
 - b. Or Equal Products not acceptable for this item.

E. Liquid-Soap Dispenser:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. GOJO Dispenser
 - 1) Model: FMX-12.
 - 2) Color: Dove Gray.
 - b. Or Equal Products not acceptable for this item.

F. Grab Bar:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bobrick Washroom Equipment, Inc.
 - b. Bradley Corporation.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
4. Outside Diameter: 1-1/4 inches.
5. Configuration and Length: As indicated on Drawings.

G. Seat-Cover Dispenser:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Tork Toilet Seat Cover Dispenser.
 - 1) Model: 344080.
 - 2) Color: Black.
 - b. Or Equal Products not acceptable for this item.

H. Mirror Unit:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bobrick Washroom Equipment, Inc.
 - 1) Model: B-293.
 - b. Bradley Corporation.
2. Frame: Stainless steel, fixed tilt.
 - a. Corners: Manufacturer's standard.
3. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
 - b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
4. Size: As indicated on Drawings.

2.2 UNDERLAVATORY GUARDS

A. Underlavatory Guard:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Plumberex Specialty Products, Inc.
 - b. Truebro by IPS Corporation.
2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded plastic, white.

2.3 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating.

- C. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- D. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- E. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.4 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ansul by Johnson Controls Company.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Larsens Manufacturing Company.
 2. Valves: Manufacturer's standard.
 3. Handles and Levers: Manufacturer's standard.
 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type in Aluminum Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Ansul by Johnson Controls Company.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Larsens Manufacturing Company.

- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Engineer.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
- C. Verify that each fire extinguisher is present at Substantial Completion. Replace missing fire extinguishers with new to match specified product at no additional cost to District.

END OF SECTION 104416

PART 1 - SECTION 133424 – FABRICATED FIBERGLASS STRUCTURE GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Engineered, fabricated fiberglass structure complete and ready for operation as indicated on Drawings..
2. Provide The FRP building with the following:
 - a. Vapor-tight LED Light
 - b. Light switches
 - c. Doors
 - d. Lifting eyes
 - e. Stainless steel hardware

B. Related Requirements:

1. Section 013300 “Submittal Procedures”
2. Section 017823 “Operation and Maintenance Data”
3. Section 033000 “Cast-in-Place Concrete”
4. Section 099100 “Painting”

1.3 ACTION SUBMITTALS

- A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of Section 013300. Submittals shall include at least the following:

1. Resin used.
2. Certified independent test results of the representative wall laminate.
3. Certified shop drawings showing the following:
 - a. Critical dimensions, jointing and connections, fasteners and anchors. All other important details of construction, dimensions, and anchor bolt locations.
 - b. Materials of construction.
 - c. Sizes, spacing and location of structural members, connections, attachments, openings, and fasteners.
 - d. Color
4. Descriptive literature, bulletins, and/or catalogs of the equipment.

5. The total weight of the equipment.
6. Structural design calculations signed and sealed by a Professional Engineer registered in the State of Florida.
7. All information required by Section 013300.
8. Complete wiring diagrams and schematics of all power systems showing wiring requirements between all system components including connections to work of other Sections.
9. Certification by the supplier that the equipment and materials to be provided are suitable for the service intended.
10. In the event that it is impossible to conform with certain details of the Specifications due to different manufacturing techniques, describe completely all non-conforming aspects.

1.4 CLOSEOUT SUBMITTALS

- A. Operating and Maintenance Data:
 1. Provide instructions specifically for this installation including all required cuts, drawings, equipment lists, descriptions, etc. required to instruct operating and maintenance personnel unfamiliar with such equipment.
- B. Project Record Documents: Record actual locations of concealed components and utilities.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Provide special tools required for normal operation and maintenance.

1.6 QUALITY ASSURANCE

- A. Perform Work according to Florida Building Code and ASCE 7-10 standards, whichever is greater.
- B. Surface-Burning Characteristics for Insulation Installed in Concealed Locations:
 1. Foam Insulation:
 - a. Maximum Flame-Spread/Smoke-Developed Index: 25/450.
 - b. Testing: Comply with ASTM E84.
- C. Surface-Burning Characteristic for Insulation Installed in Exposed Locations:
 1. Maximum Flame-Spread/Smoke-Developed Index: 25/450.
 2. Testing: Comply with ASTM E84.
- D. Comply with Florida Building Code for submission of design calculations, reviewed Shop and erection drawings as required for acquiring permits.
- E. Provide components of each type from one manufacturer, and compatible with adjacent materials.

F. Vapor Retarder Permeance:

1. Maximum 1 perm.
2. Testing:
 - a. Comply with ASTM E96/E96M.
 - b. Method: Water.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.
- B. Production capacity to provide work required for this Project without delay.
- C. Certified Test Results: Provide destructive test of entire fiberglass panel by an accredited Testing Laboratory and Third Party Quality Control Agency and upon request furnish to the engineer the certified and stamped test results of the laboratory testing. The accredited Testing Laboratory must be accredited to ISO 17020 and 17025. The manufacturer shall maintain a quality assurance program that is also certified by an accredited Testing Laboratory and Third Party Quality Control Agency and furnish to the engineer the certified and stamped quality assurance program by an accredited Testing Laboratory and Third party Quality Control Agency.
- D. Erector: Company specializing in performing Work of this Section with minimum two years' documented experience.
- E. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Florida.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. The fiberglass shelter and the accessory items shall be carefully transported, stored, handled and set in place in a manner that will prevent distortion, misalignment or other damage to the units.
- C. During storage prior to installation and following installation, but prior to placing in service, follow the manufacturer's recommendations concerning handling.
- D. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- E. Store materials according to manufacturer's written instructions.
- F. Protection:
 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 2. Provide additional protection according to manufacturer instructions.

1.9 FIELD CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

- A. Section 017700 "Closeout Procedures": Requirements for warranties.
- B. Furnish two-year manufacturer's warranty for pre-engineered building materials and workmanship..
- C. Furnish two-year manufacturer's warranty for exterior prefinished surfaces' color coat against chipping, cracking or crazing, blistering, peeling, chalking, and fading, including coverage for weathertightness of building enclosure elements after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In order to set a level of quality, fabricated fiberglass structures shall be provided by one of the following manufacturer's:
 1. Tracom Inc.
 2. Shelter Works
 3. Engineer approved Equal.
- B. System Description
 1. Provide a one-piece construction FRP building of the following type:
 2. B-101 Enclosure:
 - a. Size: 5'-0" width x 14'-6" depth x 7'-6" peak height
 - b. The roof pitch shall be 1:12 minimum
 3. B-102 Enclosure:
 - a. Size: 7'-0" width x 18'-0" depth x 7'-6" peak height
 - b. The roof pitch shall be 1:12 minimum
 4. Supply molded composite construction FRP building suitable for installation as shown in the Drawings. Provide the building with a smooth interior and exterior satin finish. The walls and roof shall be integral with smooth radii for all corners. No roof overhang allowed. External section connection flanges are not allowed.

- C. Provide enclosures with LED lights. Provide weather proof light switch at the exterior front of the building.
- D. Provide doors with stainless steel laminated butt hinges, overhead door stop, rubber bulb door jamb and head seal gasket, stainless steel threshold with neoprene gasket, and stainless steel closing with hold open arm hardware. All door hardware to be heavy-duty non-corrosive.
- E. Designed and proportion all equipment to have liberal strength, stability and stiffness and to be specifically adapted for the intended service.
- F. Rigidly and accurately anchor the shelter into position with necessary foundation bolts, plates, nuts and washers. Provide Type 316 stainless steel Anchor bolts.
- G. Laminate:
 - 1. Isophthalic polyester resin with high performance, chopped, commercial grade glass strand fiber reinforcement with a suitable coupling agent.
 - 2. Minimum glass content: 30%.
 - 3. Exterior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a satin finish lightly textured and free from fiber pattern, roughness, or other irregularities.
 - 4. Exterior laminate: 1/8 inch thick (minimum); chemically bonded to the surface gel coat and encapsulating the foam core.
 - 5. Foam core (see below)
 - 6. Interior laminate: 1/8 inch thick (minimum); chemically bonded to the interior gel coat and encapsulating the foam core.
 - 7. Interior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a textured finish, free from exposed glass or other irregularities.
 - 8. Laminate properties:
 - a. Tensile strength (ASTM D 638): 14,000 PSI.
 - b. Flexural strength (ASTM D 790): 27,000 PSI.
 - c. Flexural modulus (ASTM D790): 1,000,000 PSI.
 - d. Shear strength (ASTM D 732): 12,000 PSI.
 - e. Barcol hardness (ASTM D 2583): 40.
 - f. Density / specific gravity (ASTM D 792): 93.6 PCF/1.5.
- H. Core
 - 1. Rigid closed cell, self-extinguishing (Class 1), polyisocyanurate foam with a density of 2.5 pounds per cubic foot. Lower density foams shall not be acceptable.
 - a. 1-inch-thick with an initial insulating value of R~7
 - 2. Core properties:
 - a. Thermal conductivity (ASTM C 518): 0.145 BTU inch/hr./SF/°F.
 - b. Density / specific gravity (ASTM D 1622): 2.5 PCF.
 - c. Shear Strength (ASTM C 273): 25 lb/in²
 - d. Tensile Strength (ASTM D 1623): 45 lb/in²

- e. Compressive Strength (7% deflection/yield)
- f. (ASTM D 1621): 35

- I. Coupons prepared in accordance with ASTM D 618.
- J. The manufacturer shall maintain a continuous quality control program and upon request shall furnish to the Engineer certified test results of the physical properties.

2.2 COMPONENTS

A. Doors:

1. Construction:

- a. Each door shall be one-piece molded fiberglass construction 78 inches high, 1 ¾ inches thick and 36 inches wide.
- b. Mount door with two T-304 stainless steel laminated butt hinges, 5 inches long. Door must be readily replaceable – the use of continuous piano hinges or fastening methods other than bolting are not acceptable.
- c. Rubber bulb gasket with flexible lock to retain permanent grip.
- d. One-piece, purpose built, 3 inches deep fiberglass drip cap over doors; drip cap to extend 2 inches each side past door.
- e. Full threshold, stainless steel type 304, 5 inches deep x 1/2 inch high.
- f. Schlage stainless steel single-point key locked classroom style, lever handle with interior panic bar egress, drop handle with accommodation for user-supplied padlock. To facilitate entry and exit from the building, raised or integral door sills are not acceptable.
- g. Heavy duty stainless steel, dual compression spring cushioned overhead door stop, designed for BHMA L52231 and ANSI A156.16.
- h. Provide single-flap neoprene insert style door sweep.
- i. Provide 12-inch by 12-inch Lexan door window

- B. Lifting Eyes: Provide a minimum of two removable, 3/4 inch – 10 partially threaded, eye bolts with 6-inch shank lengths.

- 1. Steel (5,200 lbs. work load limit).

- C. Mounting Flange: 3 inches wide x 1/4-inch-thick (minimum) with closed cell neoprene sponge rubber gasket 2 inches wide x 3/8 inch thick to provide a weather tight seal around the interior of the building perimeter.

2.3 LIGHTING

A. General

- 1. Provide conduit in strict accordance with Section 260519.
- 2. Provide lighting layout by the building manufacturer. Prewire necessary exterior and interior fixtures specified herein. Provide a minimum of 30-foot candles of illumination

measured 3 foot above the floor. Place lights as close as practical to the center of each building

3. Furnish all electrical items, pre-wired and installed by the building manufacturer as shown on the drawings and as specified above.

B. B-101 Interior Lighting

1. Pendant mounted led light fixture; 6400 nominal lumens; 5000k cct; 70 cri; copper-free, cast aluminum housing; tempered glass lens; 1/2" hub; captive stainless steel fasteners and inserts; type v wide 120°; polyester powder coat gray finish; 50°c ambient temperature rating; 120,000 hour l70 rated lifetime projection

C. B-102 Interior Lighting

1. Pendant mounted led light fixture; 6400 nominal lumens; 5000k cct; 70 cri; copper-free, cast aluminum housing; tempered glass lens; 1/2" hub; captive stainless-steel fasteners and inserts; type v wide 120°; polyester powder coat gray finish; 50°c ambient temperature rating; 120,000 hour l70 rated lifetime projection. Hazardous location ul844 class i, div2; NEMA 4X, ip66, ul 1598 and 1598a listed; multivolt (120-277v).

D. Exterior Lighting

1. LED emergency sconce; wall mounted full cutoff fixture; single piece die-cast aluminum housing and door frame; memory retentive gasket seals; stainless steel hardware; acrylic diffuser lens; 3000 initial lumens, 4000k, type 4 forward throw light distribution; polyester powdercoat dark bronze finish; led thermal management; universal voltage (120-277v); csa certified to us standards; wet location; photocell; integral emergency battery pack.

2.4 SURFACE PREPARATION AND SHOP PRIME PAINTING

- A. Surface preparation and shop painting is included as a part of the work of this Section and shall be as specified under Division 9.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify that the concrete slab is level, true to plane, and of the correct dimensions to receive the mounting flange of the structure. Contractor shall correct all deficiencies before proceeding with installation.
- B. Install products in accordance with Engineer's plans and instructions, local codes, and in a manner consistent with the installation instructions and recommendations of the manufacturer.
- C. Do not remove the door spacers until all anchor bolts have been completely set and door operation has been verified.

- D. Move and position the FRP building using the lifting eyes. The neoprene gasket provided with the building should be positioned between the concrete slab and the building mounting flange. Use a spreader bar to lift building.
- E. Do not Fabricate or erect the FRP building until:
 - 1. The anchor bolt layout and details have been submitted to and approved by the Engineer.
 - 2. The foundation design and details have been finalized by the Engineer for the selected building system.
- F. Install anchor bolts following Manufacturer's recommendations.
 - 1. Drill and set the anchor bolts starting with one on each side of the doors. Verify the operation of the doors before installing the remaining anchor bolts.
 - 2. Drill the anchor bolt holes to the depth and diameter required by the anchor bolt manufacturer.
 - 3. Verify operation of the doors after installation of anchor bolts and threshold.
- G. Seal the flange with sealant or grout to ensure water tightness.
- H. Install (as necessary) and test the building accessories in accordance with the manufacturers' instructions.

3.2 ADJUSTING AND CLEANING

- A. Clean surfaces in accordance with manufacturer's instructions.
- B. Remove trash and debris, and leave the site in a clean condition.

END OF SECTION 133424

SECTION 304213 - PRECAST CONCRETE BUILDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes precast concrete building, including the following:

1. Exterior walls
2. Roof slab
3. Floor slab
4. Interior finishes
5. Doors.
6. Mechanical and electrical components and equipment

- B. Related Requirements:

1. Division 26 for electrical work.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, appurtenances and finishes for precast concrete building.

- B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of reinforcing, joints, opening and door location and detail, louver location and details, dampers, fans and other heating and ventilating equipment details.
3. Detail fabrication and assembly of **<Insert portion of Work>**.
4. Include diagrams for power, signal, and control wiring.

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

- D. Product Schedule: For the following:
 - 1. For door hardware. [Use same designations indicated on Drawings.]
 - 2. Equipment. [Use same designations indicated on Drawings.]
- E. Delegated-Design Submittal: For structural design calculations and drawings for the precast reinforced concrete building. The structural drawings and calculations shall be prepared and stamped by a professional engineer registered in the State of Florida.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer manufacturer fabricator.
- B. Welding certificates.
- C. [Product] Certificates: For each type of <Insert material or product>.
- D. Material Test Reports: For each <**Insert material**>, by a qualified testing agency.
- E. Product Test Reports: For each <Insert product>, for tests performed by [manufacturer and witnessed by a qualified testing agency] [a qualified testing agency].
- F. Evaluation Reports: For <**Insert products, assemblies, or systems**>, from ICC-ES.
- G. Preconstruction Test Reports: For <**Insert item**>.
- H. Source quality-control reports.
- I. Field quality-control reports.
- J. Sample Warranty: For [**manufacturer's**] [**special**] warranty.

1.6 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide prefabricated concrete structure capable of withstanding the design loads as shown on the structural drawings.

1.7 DESIGN REQUIREMENTS

- A. Structure Interface and Integration with Building: Design precast concrete units to integrate and interface with building components, concrete structures, mechanical and electrical components, and other related systems. Provide precast concrete units to conform to the dimensions and configurations shown on the contract bid documents.
- B. Precast concrete structures shall be cast as four, five, or six-sided as dictated by project design.

1.8 QUALITY ASSURANCE

- A. General: Precast Concrete Structure Manufacturer shall perform work in compliance with applicable requirements of ACI 318, and PCI MNL-116, PCI MNL-120, PCI MNL-123, PCI MNL-124, and PCI MNL-127.
- B. Manufacturer Qualifications: A firm that complies with the following requirements and is experienced in producing precast concrete units similar to those indicated for this Project and with a record of successful in-service performance.
 - 1. Assumes responsibility for engineering structural precast concrete units to comply with performance requirements. The responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
 - 2. Has sufficient production capacity to produce required units without delaying the Work.
 - 3. Is registered with and approved by authorities having jurisdiction.
 - 4. Must have a minimum of ten (10) years documented experience in the design and production of precast concrete building components.
 - 5. Must have a minimum of ten (10) completed projects of equal size and magnitude of this project.
- C. Design Standards: Comply with ACI 318 (ACI 318M) and the design recommendations of PCI MNL 120, "PCI Design Handbook – Precast and Prestressed Concrete," applicable to types of structural precast concrete units indicated.
- D. Quality-Control Standard: For manufacturing procedures and testing requirements and quality control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Concrete Products."
- E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.9 DELIVERY, STORAGE, AND HANDLING

- A. All handling, loading, shipping, lifting and installation of the building shall be performed in strict accordance with the manufacturer's written instructions, which shall accompany the building.
- B. The Contractor shall require the manufacturer to assume responsibility for packing to prevent transit and handling damage to the concrete.
- C. The building shall be provided with lifting lugs for moving the building. Install the building on fully cast-in-place concrete beams as shown on the structural drawings. Lift and support units only at designated points shown on the Shop Drawings
- D. Store units with adequate dunnage and bracing and protect units to prevent contact with soil, staining, and to prevent cracking, distortion, warping or other physical damage.
- E. Store units, unless otherwise specified, with dunnage the full length of long walls of each building.

- F. Place stored units so identification marks are clearly visible, and units can be inspected.
- G. Deliver all structural precast concrete units in such quantities and at such times to assure compliance with the schedule and proper setting sequence to ensure continuity of installation.
- H. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses which would cause cracking or damage.

PART 2 - . PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. List manufacturers' names in alphabetical order.
 - 2. Fibrebond Corporation
 - 3. Smith Midland
 - 4. Oldcastle.

2.2 PRECAST CONCRETE BUILDING

- A. Provide a prefabricated, fully reinforced, modular precast concrete building, with all openings, sleeves, sealing elements, doors, and other appurtenances included. Plant fabricated monolithic wall and roof construction, with floor cast as a secondary pour connected to the walls.
- B. Exterior Dimensions: 12'-0" wide by 37'-6" long by 12'-6" high.
- C. Exterior Wall Finish: Formed with rubbed smooth finish
- D. Roof Finish: Formed with rubbed smooth finish
- E. Thermal Performance: As follows:
 - 1. Roofing: R = <Insert R value>
 - 2. Walls: R= <Insert R value>
 - 3. Flooring: R= <Ineert R value>
- F. Concrete: Minimum compressive strength of 5000 psi at 28 days. Keep water to a minimum to obtain concrete which is as dense and watertight as possible.
 - 1. Maximum Water Content: 6 gallons per 94 pound sack and the minimum cement factor shall be 6.0 sacks per cubic yard.
- G. Design Criteria: Conform to ACI 318 for building.
 - 1. When the design yield strength f_y for tension reinforcement exceeds 40,000 psi:
 - a. "Z" values referred to in ACI 318: Not to exceed 115 ksi.

- b. The calculated flexural stress in reinforcement under service loads "FS": Not greater than 50 percent of the specified yield strength f_y .
 - 2. Design the precast reinforced concrete building elements to support their own weight and an 80-lb/sq ft roof snow load plus a 10-lb/sq ft roof live load.
 - 3. Walls: wind pressure as shown on the structural drawings.
 - 4. Design and detail all members and connections providing resistance to lateral wind and/or seismic forces. Provide metal connecting members of stainless steel construction, when provided.
 - H. Analyze slabs and walls by accepted engineering principles. Frame openings to carry the full design loads to the supporting wall or slab. Fully reinforce the base slabs on both faces with minimum reinforcing of No. 4 at 12-in E.F.E.W. Provide additional reinforcing around all openings.
 - I. Fully protect all insulation from direct exposure with approved fire protective materials.
 - I.
 - I. Furnish three change keys and three construction day keys
- 2.3 BUILDING INTERIOR
- A. Fiberglass Reinforced Plastic Panels over rigid insulation.
- 2.4 BUILDING EXTERIOR
- A. The exterior wall finish shall be a pre-cast architectural sand finish. Exterior walls to be painted per specification section 09902. The color shall be selected and approved by Owner from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Place the building level and located as indicated on the Drawings. Confirm the exact location with the Engineer prior to excavation for the sub-base.
- B. All steel surfaces to come in contact with concrete shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.

END OF SECTION 304213

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Silicone sealants.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anticorrosion coated, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. 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.
- 3. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

- 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: PVC pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: PVC pipe sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
 - d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
 - e. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
 - f. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - h. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - i. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - j. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - k. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - m. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - n. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - o. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
 - p. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
 - q. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - r. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
 - s. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.

- t. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor plate.
 - 2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections.
 - 6. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES

- A. Bronze Ball Valves, One-Piece with Bronze Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. WATTS.
 - 2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 400 psig.
- c. Body Design: One piece.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Bronze.
- h. Ball: Chrome-plated brass.
- i. Port: Reduced.

B. Bronze Ball Valves, One-Piece with Stainless-Steel Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. WATTS.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Reduced.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Brass ball valve, one piece.
 - 2. Bronze ball valve, one piece with stainless steel trim.
 - 3. Brass ball valves, two-piece with full port and stainless steel trim.

END OF SECTION 220523.12

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal hanger-shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe-positioning systems.
10. Equipment supports.

- B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

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

1. Detail fabrication and assembly of trapeze hangers.

2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to [ASCE/SEI 7] **<Insert requirement>**.
 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment[**and obtain approval from authorities having jurisdiction**].

2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Indoor Applications: Zinc-coated or stainless steel.
 2. Outdoor Applications: Stainless steel.

2.4 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.5 EQUIPMENT SUPPORTS

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

2.6 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. 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.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.
- J. 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] <Insert size> 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.

- K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 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 allowed by 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 or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 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 bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

3.5 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.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099100 "Painting."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 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 finishes.

- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal hanger-shield inserts for insulated piping and tubing.
- I. 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 up to 1050 deg F pipes NPS 4 to NPS 24, 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 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. 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 or carbon-steel plate.
 - 15. 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 or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. 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.
 - 17. 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 occurs.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
 20. 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 occurs and vertical adjustment is unnecessary.
 21. 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, in addition to expansion and contraction, is required.
- J. 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 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. 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 of 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.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548.13 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric hangers.
3. Spring hangers.

- B. Related Requirements:

1. Section 230548.13 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.3 ACTION SUBMITTALS

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

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

- B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

- C. Delegated-Design Submittal: For each vibration isolation device.

1. Include design calculations for selecting vibration isolators.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads: .
 - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 2. Size: Factory or field cut to match requirements of supported equipment.
 - 3. Pad Material: Oil and water resistant with elastomeric properties.
 - 4. Surface Pattern: Smooth or Waffle pattern.
 - 5. Infused nonwoven cotton or synthetic fibers.
 - 6. Load-bearing metal plates adhered to pads.
 - 7. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth or Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .
 - 1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.3 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 220548.13

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION 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.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Letter Color: White .
 - 3. Background Color: Blue.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 5. Minimum Letter Size: 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-quarters the size of principal lettering.
 6. Fasteners: Stainless-steel rivets or self-tapping screws.
 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 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-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: **aluminum, 0.032-inch** minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Description: 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."
 - 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- 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.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Painting."
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule:
 - 1. Domestic Water Piping:
 - a. Background: Safety green.
 - b. Letter Colors: White.

2. Sanitary Waste Piping:
 - a. Background Color: Safety black.
 - b. Letter Color: White.
3. Protected Water Piping:
 - a. Background: Safety green.
 - b. Letter Colors: White.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - c. Protected Water: 1-1/2 inches, round.
 2. Valve-Tag Colors:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - c. Protected Water: Natural.
 3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.
 - c. Protected Water: White.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Roof drains and rainwater leaders.
 - 4. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - 2. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - 3. Sheet Jacket Materials: 12 inches square.
 - 4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing 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 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.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 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.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.
 - 1. Not typically used
 - 2. Pittsburgh Corning Foamglas.
 - 3. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Pittsburgh Corning Corporation.
 - 4. Block Insulation: ASTM C 552, Type I.
 - 5. Preformed Pipe Insulation: Type II, Class 1, without jacket.
 - 6. Preformed Pipe Insulation: Type II, Class 2, with factory-applied ASJ-SSL jacket.
 - 7. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
 - 8. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.
- H. Armacell AP Armaflex

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

1. Aeroflex USA.
2. Armacell LLC.
3. K-Flex USA.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
- C. Mineral-Fiber, Hydraulic-

2.3 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. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
- C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
 1. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 2. Wet Flash Point: Below 0 deg F40 to 200 deg FColor: **[Black]** <Insert color>
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Barrier Mastic, Water Based: Suitable for indoor use on below-ambient services.
 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 2. Service Temperature Range: [0 to plus 180 deg FMinus 20 to plus 180 deg F.
 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 4. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.
 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 2. Service Temperature Range: 0 to 180 deg F.
 3. Color: White.

- D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 - 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 3. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 - 1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: [0 to plus 180 deg F [Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.5 LAGGING ADHESIVES

- A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 2. Service Temperature Range: 20 to plus 180 deg F 0 to plus 180 deg F.
 - 3. Color: White.

2.6 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 - 1. Permanently flexible, elastomeric sealant.
 - 2. Service Temperature Range: Minus 58 to plus 176 deg F Minus 100 to plus 300 deg F.
 - 3. Color: White or gray.

2.7 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 C1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

2.9 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..

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-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) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.

5. Tensile Strength: 40 lbf/inch in width.
 6. 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 C1136.
1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A240/A240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

2.13 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers,:
1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures,:
1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature of 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 tradesman 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.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of 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 storage, application, and finishing. Replace insulation materials that get wet.
- 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 attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and 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 **4 inches** o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 25 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 in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof 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 roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. 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.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

- 1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
- 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
- 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
- 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

- 1. Install preformed 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 cellular-glass block insulation of same thickness as that of pipe insulation.
- 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's 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 that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's 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.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 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. 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.

3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 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.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- 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 Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- F. All insulation applications will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.11 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. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 3/4 inch thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inch thick.
 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 2 inches thick.
 - b. Flexible Elastomeric: 2 inch thick.
- C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1/2 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. None.
- D. Piping, Exposed:
 1. None.
 2. Aluminum, Smooth: 0.016 inch thick.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. CPVC piping.
 - 2. Piping joining materials.
 - 3. Encasement for piping.
 - 4. Transition fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- C. Comply with NSF 372 for low lead.

2.2 CPVC PIPING

- A. CPVC Pipe: ASTM F441/F441M, Schedule 80.
 - 1. CPVC Socket Fittings: ASTM F439 for Schedule 80.
 - 2. CPVC Threaded Fittings: ASTM F437, Schedule 80.
- B. CPVC Piping System: ASTM D2846/D2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D2846/D2846M, SDR 11, tube and socket fittings.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys.
- D. Flux: ASTM B813, water flushable.
- E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F493.

2.4 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.

3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
- D. Plastic-to-Metal Transition Fittings:
 1. Description:
 - a. CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.
- E. Plastic-to-Metal Transition Unions:
 1. Description:
 - a. CPVC four-part union.
 - b. Brass or stainless-steel threaded end.
 - c. Solvent-cement-joint or threaded plastic end.
 - d. Rubber O-ring.
 - e. Union nut.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 312000 "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.

- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. 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.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install PEX tubing with loop at each change of direction of more than 90 degrees.
- R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump.
- T. Install thermostats in hot-water circulation piping.
- U. Install thermometers on outlet piping from each water heater.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. 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.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- L. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 2. CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 3. PVC Piping: Join according to ASTM D2855.
- M. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Vertical Piping: MSS Type 8 or 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install vinyl-coated hangers for CPVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Install vinyl-coated hangers for PEX tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support horizontal piping within 12 inches of each fitting.

- F. Support vertical runs of CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- G. Support vertical runs of PEX tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Piping Inspections:
 - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.

- 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
 - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
 - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

- D. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
 - 1. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
 - 2. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
- E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
 - 1. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
 - 2. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 - 3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Vacuum breakers.
 - 2. Backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Temperature-actuated, water mixing valves.
 - 5. Strainers.
 - 6. Hose stations.
 - 7. Hose bibbs.
 - 8. Water-hammer arresters.
 - 9. Trap-seal primer valves.
 - 10. Specialty valves.
 - 11. Flexible connectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14. Mark "NSF-pw" on plastic piping components.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: refer to drawings
5. Design Inlet Pressure: 90 psig
6. Design Outlet Pressure Setting: 60 psig
7. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
8. Valves for Booster Heater Water Supply: Include integral bypass.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.6 WATER MIXING VALVES

A. Water-Temperature Limiting Devices

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Leonard Valve Company.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded or union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 104 deg F.
9. Tempered-Water Design Flow Rate: 0.5 gpm.
10. Valve Finish: Rough bronze.

2.7 HOSE STATIONS

A. Single-Temperature-Water Hose Stations:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Leonard Valve Company.
 - b. T&S Brass and Bronze Works, Inc.
2. Standard: ASME A112.18.1.
3. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.
6. Body Finish: Rough bronze.
7. Mounting: Wall, with reinforcement.
8. Supply Fittings: NPS 3/4 globe, or ball valve and check valve and NPS 3/4 copper, water tubing. Omit check valve if check stop is included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 50 feet long.
10. Nozzle: With hand-squeeze, on-off control.
11. Vacuum Breaker:
 - a. Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.8 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.9 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.10 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Precision Plumbing Products.
 - b. WATTS.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International or equal.
2. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 minimum, trap makeup connection.
3. Size: NPS 1-1/4 minimum.
4. Material: Chrome-plated, cast brass.

2.11 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping."

B. CPVC Union Ball Valves:

1. Description:

- a. Standard: MSS SP-122.
- b. Pressure Rating and Temperature: 125 psig at 73 deg F.
- c. Body Material: CPVC.
- d. Body Design: Union type.
- e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
- f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded or flanged.
- g. Ball: CPVC; full port.
- h. Seals: PTFE or EPDM-rubber O-rings.
- i. Handle: Tee shaped.

C. CPVC Non-Union Ball Valves:

1. Description:

- a. Standard: MSS SP-122.
- b. Pressure Rating and Temperature: 125 psig at 73 deg F.
- c. Body Material: CPVC.
- d. Body Design: Non-union type.
- e. End Connections: Socket or threaded.
- f. Ball: CPVC; full or reduced port.
- g. Seals: PTFE or EPDM-rubber O-rings.
- h. Handle: Tee shaped.

2.12 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

- 1. Working-Pressure Rating: Minimum 200 psig.
- 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
- 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

- 1. Working-Pressure Rating: Minimum 200 psig.
- 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
- 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 - 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- C. Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve.
- G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 - 1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- I. Install water-hammer arresters in water piping according to PDI-WH 201.
- J. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- K. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

- L. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Water pressure-reducing valves.
 - 4. Primary, thermostatic, water mixing valves.
 - 5. Primary water tempering valves.
 - 6. Hose stations.
 - 7. Supply-type, trap-seal primer valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. PVC pipe and fittings.
 - 2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
- C. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

1.6 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 PVC PIPE AND FITTINGS

- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F656.
- E. Solvent Cement: ASTM D2564.

2.4 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 2. Unshielded, Nonpressure Transition Couplings:

- a. Standard: ASTM C1173.
 - b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - 2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
3. Shielded, Nonpressure Transition Couplings:
- a. Standard: ASTM C1460.
 - b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - c. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earthwork."

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- 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. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.
- L. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- N. Install aboveground PVC piping according to ASTM D2665.
- O. Install underground PVC piping according to ASTM D2321.
- P. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

Q. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.
 - a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."
 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 3. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
 1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
 1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.
 1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints according to ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. PVC Piping: Join according to ASTM D2855 and ASTM D 2665 appendixes.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 1. Install transition couplings at joints of piping with small differences in ODs.
 2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.

3.5 VALVE INSTALLATION

- A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.
- B. Shutoff Valves:
 1. Install shutoff valve on each sewage pump discharge.
 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
 3. Install gate valve for piping NPS 2-1/2 and larger.

- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 - 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 - 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 - 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 - 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- E. Support vertical runs for PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main.
 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. 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.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
 - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
 - a. Isolate test source and allow to stand for four hours.
 - b. Leaks and loss in test pressure constitute defects that must be repaired.
 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
- E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
 - 1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Cleanouts.
 - 2. Air-admittance valves.
 - 3. Miscellaneous sanitary drainage piping specialties.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene.
- B. FOG: Fats, oils, and greases.
- C. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.
 - 2. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For FOG disposal systems, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. Zurn Industries, LLC.
- 2. Standard: ASME A112.36.2M.
- 3. Size: Same as connected drainage piping
- 4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- 5. Closure: Countersunk, brass plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. Zurn Industries, LLC.
- 2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
- 3. Size: Same as connected branch.
- 4. Type: Heavy-duty, adjustable housing.
- 5. Body or Ferrule: Cast iron.
- 6. Clamping Device: Required.

7. Outlet Connection: Inside calk.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
 - a. Brass.
 - b. Countersunk or raised head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
7. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.3 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProVent Systems.
 - b. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

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

- a. Oatey.
 - b. Studor, Inc.
- 2. Standard: ASSE 1050 for vent stacks.
 - 3. Housing: Plastic.
 - 4. Operation: Mechanical sealing diaphragm.
 - 5. Size: Same as connected stack vent or vent stack.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

- 1. Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
- 2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

- 1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
- 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

- 1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
- 2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

2.5 MOTORS

A. General requirements for motors are specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

- 1. Motor Sizes: Minimum size as indicated. If not indicated, motor shall be large enough, so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:

- 1. Install FOG disposal systems on cast-in-place concrete equipment base(s).

- a. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 2. Comply with requirements for vibration-isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 3. Comply with requirements for vibration-isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."
- B. Install backwater valves in building drain piping.
1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install fixture air-admittance valves on fixture drain piping.
- G. Install stack air-admittance valves at top of stack vent and vent stack piping.
- H. Install air-admittance-valve wall boxes recessed in wall.
- I. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- J. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- K. Assemble open drain fittings and install with top of hub 1 inch above floor.
- L. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- M. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.

- N. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- O. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- P. Install vent caps on each vent pipe passing through roof.
- Q. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- R. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- S. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- T. Assemble components of FOG disposal systems and install on floor.
 - 1. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction.
 - 2. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated.
 - 3. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
- U. Install wood-blocking reinforcement for wall-mounting-type specialties.
- V. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

- A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- D. Set flashing on floors and roofs in solid coating of bituminous cement.
- E. Secure flashing into sleeve and specialty clamping ring or device.
- F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. FOG disposal systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.
 - 1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections, and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and their installation, including piping and electrical connections, and to assist in testing.
- B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 221319

SECTION 221319.13 - SANITARY DRAINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Floor drains.
 - 2. Trench drains.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene styrene.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
10. Sediment Bucket: Top or Strainer Material: Nickel bronze.
11. Top Shape: Round.
12. Dimensions of Top or Strainer: 6-inch.
13. Top Loading Classification: Heavy Duty.
14. Funnel: Not required.
15. Inlet Fitting: Not required.
16. Trap Material: Cast iron.
17. Trap Pattern: Deep-seal P-trap.
18. Trap Features: Not required.

2.3 TRENCH DRAINS

A. Trench Drains:

1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.3 for trench drains.
3. Material: Ductile or gray iron.
4. Flange: Anchor.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Grate Material: Ductile iron.
8. Grate Finish: Painted.
9. Dimensions of Frame and Grate: Refer to plumbing drawings.
10. Top Loading Classification: Heavy Duty.

11. Trap Material: Cast iron.
12. Trap Pattern: Standard P-trap.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
 1. Set grates of drains flush with finished surface, unless otherwise indicated.
- C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.
 1. Install on support devices, so that top will be flush with adjacent surface.
- D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.
- E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.
- F. Install open drain fittings with top of hub 1 inch above floor.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221429
SOLIDS HANDLING SUBMERSIBLE CENTRIFUGAL SUMP PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install, place in operation and field test four (two at 118th Street, and two at Wilson Blvd) duplex submersible wastewater sump pumps vertically mounted on rails with quick disconnect discharge fixed base elbow as shown on the Drawings and specified herein. The equipment to be furnished and installed shall be as shown on the Drawings and shall include pumps, motors, control panels and control systems, and appurtenances, all tested and ready for operation.
- B. Each pump shall be supplied complete with the following options and the proper required anchor bolts to allow the pumps to be lowered into position without entering or reaching into the wet well and eliminates the need to bolt pump to the piping:
 - a. Corrosion-resistant Pultruded I-beam rail system.
 - b. A self-sealing flange and neoprene diaphragm to form an effective seal between the discharge flange and the base elbow flange
 - c. Pump rail removal system guides, base elbow, and quick disconnect discharge system
 - d. Lifting chains
 - e. Floats
 - f. NEMA 4X panel with float indicator L.E.D.'s allowing float monitoring without removal of wet well cover.

1.02 RELATED WORK

- A. Submittals are included in Section 013300.
- B. Operation and maintenance is included in Section 07823.
- C. Warranties are included in Section 017700.
- D. Concrete work and the installation of anchor bolts are included in Division 3; however, anchor bolts for these units as recommended by the pump manufacturer shall be furnished by the Contractor under this Section.
- E. Instrumentation and control description is included in Division 27.
- F. Valves, mechanical piping and appurtenances and pipe hangers and supports are included in Division 33.
- G. Electrical work is included in Division 26.

1.03 REFERENCE STANDARDS

- A. Design, manufacturing and assembly of elements of the equipment herein specified shall be in accordance with, but not limited to, published standards of the following, as applicable:
1. American Gear Manufacturers Association (AGMA)
 2. American Institute of Steel Construction (AISC)
 3. American Iron and Steel Institute (AISI)
 4. American Petroleum Institute (API)
 5. American Society of Mechanical Engineers (ASME)
 6. American National Standards Institute (ANSI)
 7. American Society for Testing Materials (ASTM)
 8. American Welding Society (AWS)
 9. American Bearing Manufacturers Association (ABMA)
 10. Hydraulic Institute Standards (current editions)
 11. Institute of Electrical and Electronics Engineers (IEEE)
 12. National Electric Code (NEC)
 13. National Electrical Manufacturers Association (NEMA)
 14. Occupational Safety and Health Administration (OSHA)
 15. Steel Structures Painting Council (SSPC)
 16. Underwriters Laboratories, Inc. (UL)
 17. Factory Mutual (FM)
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SYSTEM DESCRIPTION

- A. Two independent duplex sump pump systems are to be provided under this specification.
- B. Each system will pump raw wastewater from a sump to the station's wetwell.
- C. The equipment to be furnished under this Section shall include four pumps, controls and accessories (two at 118th Street MPS and two at Wilson Boulevard MPS) as specified herein and as shown on the Drawings.

1.05 QUALIFICATIONS

- A. To assure unity of responsibility, the pumps, motors, controls, and other auxiliary equipment, and materials specified in this Section shall be furnished and coordinated by the pump manufacturer (Manufacturer) who shall assume responsibility for the satisfactory operation of the entire pumping system.
- B. The pumps and other equipment covered by this Specification shall be standard production units of the manufacturers, currently available and listed in the respective manufacturer's catalogs. The pumps furnished shall be in accordance with the Hydraulic Institute Standards and shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.
- C. The Manufacturer shall have an authorized warranty center within a 300-mile radius of the job site, fully staffed with factory trained mechanics, and equipped with a stock of all necessary spare parts for each model of pump furnished under this Contract. The service facility shall be an established entity prior to delivery of equipment for this project.
- D. The controls and panels furnished shall meet all requirements of JEA standards and as specified in Division 16 and below.
- E. All equipment furnished under this Specification shall be new and unused, and shall be the standard product of Pentair (Myers).

1.06 SUBMITTALS

- A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of the General Conditions and Section 01300. Submittals shall include at least the following:
 - 1. Shop and erection drawings showing all important details of construction, dimensions and anchor bolt installation requirements.
 - 2. Descriptive literature, bulletins, and/or catalogs of the equipment. Sufficient data shall be submitted to document previous production of each pump model proposed for use on this Contract.
 - 3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves to ANSI/HI 11.6 acceptance grade 1U, based on actual factory tests of similar units, which show that they meet the specified requirements for head, flow rate, efficiency, NPSH3, submergence and horsepower. Curves shall be submitted on 8-1/2-inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from zero flow at shut off head to pump flow rate at minimum specified total head (TH). The POR and AOR (refer to ANSI/HI 9.6.3) shall be clearly shown on the curves. Catalog sheets showing a family of curves will not be acceptable.
 - 4. The total weight of the equipment including the weight of the single largest item.
 - 5. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, control panels and related systems.

6. A complete total bill of materials of all equipment.
7. A list of the manufacturer's recommended spare parts to be supplied, with the manufacturer's current price for each item. Include gaskets, seals, etc. on the list. List bearings by the bearing manufacturer's numbers only.
8. All submittal data required by the General Conditions.
9. Complete motor data, including, but not limited to:
 - a. Type of enclosure design
 - b. Rated horsepower (BHP)
 - c. Rated voltage (V)
 - d. Full Load Amps (FLA)
 - e. Starting current
 - f. Locked Rotor Amps (LRA)
 - g. Locked Rotor Kilovolt Amperes LR (KVA)
 - h. NEMA starting code letter and insulation code letter
 - i. Revolutions Per Minute RPM
 - j. Input power in kW at nameplate rating
 - k. Starting calculations
 - l. Cable size
 - m. Efficiency at 50%, 75% & 100% load, and power factor at 50%, 75% & 100% load
 - n. Winding temperature rise
 - o. Vibration design limits
 - p. Speed torque curves
 - q. Recommended trip and alarm settings for temperature and vibration protective devices
 - r. Power and control cable size and materials of construction , details of cable sealing method, description and type of motor thermal protection, description of insulation system and service factor.
 - s. Submit a certified statement from the motor manufacturer that the motors are capable of a minimum of 15 starts per hour and continuous operation on the power supply from the variable frequency drives to be furnished without affecting their design life for bearings or windings. This requirement does not replace nor relieve submittal requirements under Division 16.
10. Certified agreement to the conditions of the warranty.
11. Submit description of factory test plan including test procedures and equipment.
12. Submit for approval results of factory testing and field testing.
13. Critical speed analyses report including the specified Campbell diagrams and a statement of guarantee that the critical speed analyses as required in Paragraph 1.05G. of this Section have been completed and that the specified limitations will be met.

1.07 MANUFACTURER SERVICES INCLUDING OPERATING INSTRUCTIONS

A. Operating and Maintenance Manual:

1. Operating and maintenance manual shall be furnished by the Manufacturer to the Engineer as provided for in Section 01730. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, description, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data, full preventative maintenance schedules, and complete spare parts lists with ordering information.

B. Installation Inspection and Startup:

1. The Contractor shall include in his bid price the services of a Manufacturer's factory representative who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and start-up. If there are difficulties in operation of the equipment because of the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner. The listed service requirements are exclusive of travel time, and shall not limit or relieve the Contractor of the obligation to provide sufficient service necessary to place the equipment in satisfactory and functioning condition. Also refer to requirements in PART 3 of this Section.
2. Installation inspection: Complete review of installation in accordance with Section 01465. Provide written certification that the installation is complete and operable in all respects, and that no conditions exist which may affect the warranty. The Manufacturer shall supply the installation inspection services of an experienced Manufacturer's factory representative to verify the proper pump installation. Qualified supervisory services, including Manufacturers' Factory representatives, shall be provided to ensure that the installation is done in a manner fully approved by the Manufacturer. The Manufacturer's factory representative shall specifically approve the installation and alignment of the pump with the motor, the grouting, and the alignment of the connecting piping and the installation of the field installed packing or mechanical seal. If there are difficulties in the start-up or operation of the equipment due to the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner. Services of the Manufacturer's factory representative and training shall be provided when the first pump is started, with follow-up visits upon start-up of each subsequent pump.
 - a. Minimum time on-site shall be one 8-hour day per station.
3. Start-Up: Provide written report, summarizing test procedures, tested and measured variables (flow rates, total heads, shaft-speed, vibration measurements, etc.):
 - a. Minimum time on-site shall be one 8-hour day per station.

C. Training:

1. Field and classroom instruction on operation and maintenance of the equipment, including start-up, shut-down troubleshooting, lubrication, maintenance and safety.
2. The Manufacturer shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

3. The Manufacturer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.
 - a. Minimum time on-site shall be one 8-hour day.

1.08 TOOLS AND SPARE PARTS

- A. The Manufacturer shall furnish a complete list of recommended spare parts, gaskets, lubricants, sealants and heat transfer medium necessary for the first five years operation of each pumping system.

1.09 PRODUCT HANDLING

- A. All equipment and parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of fabrication, including storage in accordance with Manufacturer's requirements until final delivery to the job site.
- B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- C. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto or by other approved means.
- D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.
- F. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.10 WARRANTY

- A. All equipment supplied under this section shall be warranted for a period of two years by the Contractor and the Manufacturer. Warranty period shall commence on the date of Owner acceptance, as outlined in Division 1 and in Division 0.
- B. In addition, Manufacturer shall warrant the pump/motor for a period of five years, prorated after the initial 1.5 years. This Manufacturer warranty duration includes the warranty period identified above and as outlined in Divisions 1 and 0.
- C. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s) and the unit(s) restored to service at no expense to the Owner.
- D. The Manufacturer 's warranty period shall run concurrently with the Contractor 's warranty period. No exception to this provision shall be allowed.
- E. Refer to Section 01740 for additional warranty requirements.

1.11 PROJECT/SITE REQUIREMENTS

- A. Environmental Requirements: for submersible sump pump application suitable for continuous duty operation under the following service conditions:
 - 1. Environment: Indoor raw wastewater pumping application involving occasional severe duty conditions.
 - 2. Area classification: Non-hazardous.
 - 3. Maximum ambient temperature: 40 degrees C.
 - 4. Altitude: up to 45 feet above MSL.

PART 2 PRODUCTS

2.01 GENERAL

- A. The pumping units required under this Section shall be complete including pumps, motors, and appurtenances with proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the work to be done. Ample room shall be provided for inspection, repairs, and adjustments.
- B. Stainless steel nameplates giving the name of the manufacturer, the rated flow rate, head, speed, and all other pertinent data shall be permanently attached to each pump and/or motor. Additional stainless steel nameplates shall be provided to be installed by the Contractor on the enclosures or other above grade location as instructed by the Engineer such that the pumps do not need to be removed to gather the information.
- C. The pumps shall be totally submersible, solids handling, rotodynamic pumps with submersible close coupled motors designed to pump raw, unscreened wastewater.

2.02 CONDITIONS OF OPERATION

- A. The pumps shall be as manufactured by Myers (Pentair).
 - 1. The pumps for 118th Street MPS shall be MS[B] 4SD500M4-4, Capacity 225 gpm @ 26 ft-TH (1 of 2 pumps in operation), 5HP,460V, 3 PH, 60 HZ, 1750,RPM.
 - 2. The pumps for Wilson Boulevard MPS shall be MS[B] 4SD500M4-4, Capacity 225 gpm @ 26 ft-TH (1 of 2 pumps in operation), 5HP,460V, 3 PH, 60 HZ, 1750,RPM.
- B. The pump shall be capable of handling a 2.5" spherical solid. The pump shall be non-overloading throughout the entire range of operation without employing service factor. The pump shall reserve a minimum service factor of 1.20. The performance curve submitted for approval shall state in addition to head and capacity performance, the pump efficiency and solid handling capability.

2.03 PUMP CONSTRUCTION

- A. Each pump shall be of the sealed submersible type.

- B. The pump volute, motor and seal housing shall be high quality gray cast iron, ASTM A-48, Class 30. The pump discharge shall be fitted with a 3" standard ASA 125 lb. flange, faced and drilled for the MS models.
- C. All external mating parts shall be machined and Nitrile O-ring sealed on a beveled edge. Gaskets shall not be acceptable.
- D. All fasteners exposed to the pumped liquids shall be 300 series stainless steel.
- E. An upper radial bearing and lower thrust bearing shall be required. Both the upper radial bearing and the lower thrust bearing shall be heavy-duty single row ball bearings that are permanently lubricated by the dielectric oil that fills the motor housing. Double row, sealed grease packed bearings shall not be acceptable. Bearings that require lubrication according to a prescribed schedule shall not be acceptable.
- F. The shaft shall be machined from a solid 400 stainless steel and be a design that is of larger diameter with minimum overhand to reduce shaft deflection and prolong bearing life.
- G. The pump shall have a mechanical single seal, Type 21. The seal shall be used with the rotating seal face being carbon and the stationary seal face to be ceramic. The seal shall be replaceable without disassembly of the seal plate and without the use of special tools. Pump-out vanes shall be present on the backside of the impeller to keep contaminants out of the seal area. Units that require the use of tungsten-carbide seals or foreign manufactured seals shall not be acceptable.
- H. Impeller shall be of the two-vane, semi-enclosed design and have pump-out vanes on the backside of the impeller to prevent grit and other materials from collecting in the seal area. Single vane design impellers that cannot be easily trimmed and that do not maintain balance with wear, causing shaft deflections and reducing seal and bearing life, are not acceptable. Impeller shall not require coating. Attempts to improve efficiency by coating impeller shall not be acceptable.
- I. Impellers shall be dynamically balanced. The tolerance values shall be as listed below according to the International Standard Organization grade 6.3 for rotors in rigid frames. [1,750 RPM, Tolerance – 0.02 in-oz./lb. of impeller weight]
- J. The impeller shall be slip fit to the shaft and key driven. A 400 series stainless steel washer and impeller bolt shall be used to fasten the impeller to the shaft. Threaded shafts for attachment of the impeller shall not be acceptable.
- K. The casing shall be of the end suction volute type having sufficient strength and thickness to withstand all stress and strain from service at full operating pressure and load. The casing shall be of the centerline discharge type equipped with an automatic pipe coupling arrangement for ease of installation and piping alignment. The design shall be such that the pumps will be automatically connected to the discharge piping when lowered into position with the guide rails. The casing shall be accurately machined and bored for register fits with the suction and casing covers.

2.04 SUBMERSIBLE MOTORS

- A. The stator, rotor and bearings shall be mounted in a sealed submersible type housing. The stator windings shall have Class F insulation (155°C or 311°F) and dielectric oil-filled motor, NEMA B design. Single-phase motors shall have thermal type overload protection with automatic reset and be capacitor start with capacitor located in the control panel. Three phase motors shall use magnetic starters with overload relays located in the control panel for further protection. Because air-filled motors do not dissipate heat as efficiently as oil-filled motors, air-filled designs shall not be acceptable.
- B. Stators shall be securely held in place with threaded fasteners so they may be easily removed in the field. No special tools shall be required for pump and motor disassembly..
- C. Cables, Conduits and Accessories
 - 1. Electrical power cord shall be SOOW or W, water resistant 600V, 90°C, UL and CSA approved and applied dependent on amp draw for size.
 - 2. The pump shall be double protected with compression fitting and an epoxy potted area at the power cord entry to the pump.
 - 3. The power cable entry into the cord cap assembly shall first be made with a compression fitting. Each individual lead shall be stripped down to the bare wire, at staggered intervals, and each strand shall be individually separated. This area of the cord cap shall then be filled with an epoxy compound potting which will prevent water contamination to gain entry even in the event of wicking or capillary attraction.
 - 4. The power cord assembly shall then be connected to the motor leads with insulated butt connectors rather than a terminal board that allows for possible leaks.
 - 5. The cord cap assembly where bolted to the motor housing shall be sealed with a Nitrile O-ring on a beveled edge to assure proper sealing.

2.05 PUMP/MOTOR PROTECTION SYSTEM/PANEL

- A. Control panels and requirement and JEA standards are provided in Division 16.

2.06 SHOP PAINTING

- A. Each pump and associated equipment shall be shop-primed and finished-coated in accordance with the Manufacturer's standard practice prior to shipment. Color shall be selected by the Engineer and an adequate supply of touch-up paint shall be supplied by the Manufacturer.
- B. All interior and exterior wetted surfaces of pumps, exterior and interior of cooling jacket and exterior of motor enclosure shall be thoroughly cleaned, dry and free of all rust, mill scale, grease, dirt, other foreign matter and supplied with Manufacturer's standard coatings meeting the requirements in Sections 09901 and 09902.
- C. All nameplates shall be properly protected during painting.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation shall be in strict accordance with the Manufacturer's instructions and recommendations in the locations shown on the Drawings. The Contractor shall furnish all required oil and grease for initial operation, if required, in accordance with the Manufacturer's recommendations. Anchor bolts shall be set in accordance with the Manufacturer's recommendations.
- B. Upon completion of each pump installation, the Manufacturer shall inspect the unit and submit a certificate stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.02 INSPECTION AND TESTING

A. General

- 1. The Engineer shall be notified in writing prior to initial shipment and/or testing, in ample time so that arrangements can be made for inspection by the Engineer.
- 2. Field tests shall not be conducted until such time that the pumping system, including controls, is complete and ready for testing.

B. Factory Pump Test

- 1. All pumps shall receive a non-witness factory test.
- 2. The Manufacturer shall factory test all pumps prior to shipment in accordance with the Hydraulic Institute standards, latest version. Flow rate, total head and Input KW shall be tested and recorded for at least five points on the pump performance curve. Test shall be performed to demonstrate that the pumps meet ANSI/HI 11.6 acceptance grade 1U for all specified points. The five points shall include the points specified in pump performance table in Paragraph 2.02.
- 3. The Manufacturer shall perform hydrostatic test on the pressure-containing parts in accordance with ANSI/HI 11.6. Test shall be conducted on each pump prior to final coating and shipment.
- 4. The Manufacturer shall perform the following test on each pump prior to shipment from factory:
 - a. Megger motor and pump for insulation breaks or moisture.
 - b. Prior to submergence, the pump shall be run dry and checked for correct rotation.
 - c. Pump shall be run for a minimum of 30 minutes in a submerged condition.
 - d. The pump shall be removed from test tank, meggered immediately for moisture and upper and lower seal unit shall be checked for water intrusion.
 - e. A written certification test report regarding the above tests shall be submitted for approval prior to shipment.

C. Field Pump Test

1. As specified in Paragraph 1.07 B., the Manufacturer shall furnish the services of a representative who shall have complete knowledge of proper operation and maintenance to inspect the final installation and supervise the test run of the equipment. The Manufacturer shall include in his price, a minimum of eight hours of a representative's time for the above tests.
2. Written test procedures shall be submitted to the Engineer for approval 30 days prior to testing.
3. The Contractor shall furnish all water, power, facilities, labor, materials, supplies and test instruments required to conduct the field testing.
4. The Final Acceptance Test shall demonstrate that all items of these Specifications have been met by the equipment as installed and shall include, but not be limited to, the following tests:
 - a. That all units have been properly installed and are in correct alignment.
 - b. The Contractor shall check for correct lubrication in accordance with manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections, if necessary.
 - c. That the units operate without overheating or overloading any parts and without objectionable vibration.
 - d. That there are no mechanical defects in any of the parts.
 - e. That the pumps can deliver the specified total head and flow rate to demonstrate that the pumps generally meet the requirements specified (factory performance test is the basis of pump acceptance).
 - f. That the pump sensors and controls perform satisfactorily as to sequence control, correct start and stop elevations, and proper level alarm functions.
5. If the pump performance does not meet the specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified.
6. A three-day continuous operating period of the pumps will be required before acceptance. If pumping system fails during the test period, the test shall be restarted (including reset of time to zero) after repair (or replacement) has been completed.

END OF SECTION

SECTION 223300 - ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermostat-control, electric, tankless, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.
- B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Electric, Tankless, Domestic-Water Heaters: One year(s).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chronomite Laboratories, Inc; a division of Morris Group International.
 - b. Eemax, Inc.
2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
4. Construction: Copper piping or tubing complying with NSF 61 and NSF 372 barrier materials for potable water, without storage capacity.
 - a. Connections: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heating Element: Resistance heating system.
 - d. Temperature Control: Thermostat.
 - e. Safety Control: High-temperature-limit cutoff device or system.
 - f. Jacket: Aluminum or steel with enameled finish or plastic.
5. Support: Bracket for wall mounting.
6. Capacity and Characteristics: Refer to Plumbing Drawings

2.3 DOMESTIC-WATER HEATER ACCESSORIES

- A. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig- maximum outlet pressure unless otherwise indicated.
- B. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
- C. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.
- D. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- E. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- F. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- C. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

- D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- G. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."
- H. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
- I. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- J. Fill electric, domestic-water heaters with water.
- K. Charge domestic-water expansion tanks with air to required system pressure.
- L. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless, electric, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION 223300

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Flushometer valves.
 - 3. Toilet seats.
 - 4. Supports.

1.3 DEFINITIONS

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, BACK-OUTLET WATER CLOSETS

- A. Water Closets: Floor mounted, back outlet, top spud.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
 - 2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Flushometer valve.
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.6 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top.
 - i. Color: White.
 - 3. Water-Closet Mounting Height: Handicapped/elderly according to ICC/ANSI A117.1.

2.2 FLUSHOMETER VALVES

- A. Lever-Handle, Diaphragm Flushometer Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Sloan Valve Company.
 - 2. Standard: ASSE 1037.
 - 3. Minimum Pressure Rating: 125 psig.
 - 4. Features: Include integral check stop and backflow-prevention device.
 - 5. Material: Brass body with corrosion-resistant components.
 - 6. Exposed Flushometer-Valve Finish: Chrome plated.

7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Consumption: 1.6 gal. per flush.
10. Minimum Inlet: NPS 1.
11. Minimum Outlet: NPS 1-1/4.

2.3 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Bemis Manufacturing Company (1655CT).
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.

2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.
5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

C. Install toilet seats on water closets.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Lavatories.
2. Faucets.
3. Supply fittings.
4. Waste fittings.
5. Supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Servicing and adjustments of automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory: Vitreous china, wall mounted, with back.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Zurn Industries, LLC.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Nominal Size: Oval, **[19 by 16 inches] [22 by 14 inches] [23 by 15 inches]**.
 - d. Faucet-Hole Punching: Three holes, 4-inch centers.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
 - 3. Support: Type II, concealed-arm lavatory carrier.
 - 4. Lavatory Mounting Height: Handicapped/elderly according to ICC A117.1.

2.2 SOLID-BRASS, MANUALLY OPERATED FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets: Manual-type, single-control mixing, commercial, solid-brass valve.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Chicago Faucets; Geberit Company.
 - 2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: Centerset.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome.
7. Maximum Flow Rate: 0.5 gpm.
8. Mounting Type: Deck, exposed.
9. Valve Handle(s): Single lever.
10. Spout: Rigid type.
11. Spout Outlet: Laminar flow.

2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
 1. NPS 1/2.
 2. Stop valves shall be lead free ¼ turn ball valves with brass ball, stem, and body construction; annealed vertical tube; and chrome plated with cast brass escutcheons. Brasscraft KT Series; McGuire Manufacturing LFBV Series; Keeney Manufacturing PCLF Series: or equal.

2.4 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
- D. Kohler K 9010 or equal, 1 1/2 in chrome plated cast brass P trap with cleanout plug. K 9015 chrome plated brass waste nipple and cast brass chrome plated escutcheons.

2.5 SUPPORTS

- A. Type II Lavatory Carrier:

1. Standard: ASME A112.6.1M.
- B. Type III Lavatory Carrier:
 1. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Service sinks.
 - 2. Sink faucets.
 - 3. Supply fittings.
 - 4. Waste fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
 - 2. Include rated capacities, operating characteristics and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For sinks to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 UTILITY SINKS

A. Utility Sinks: Stainless steel, freestanding.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Elkay Manufacturing Co.
2. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: With backsplash.
 - c. Number of Compartments: One.
 - d. Metal Thickness: 18 gauge.
 - e. Compartment:
 - 1) Dimensions: 18x21.
 - 2) Drain Location: Centered in compartment.
3. Supports: Adjustable-length steel legs.
4. Faucet(s): Sink wall mounted, 8 inch on center with pail hook and vacuum breaker. 2.0 GPM Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Wheel handle.
 - 2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.
5. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap(s):
 - 1) Size: NPS 3.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
 - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor

insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Grout.
 - 3. Silicone sealants.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anti-corrosion coated, with plain ends and integral welded waterstop collar.
- C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- D. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. 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.
 - 3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls Above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - 2. Interior Partitions:
 - a. Piping Smaller Than NPS 6: PVC-pipe sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Fiberglass pipe hangers.
 - 4. Metal framing systems.
 - 5. Fiberglass strut systems.
 - 6. Thermal-hanger shield inserts.
 - 7. Fastener systems.
 - 8. Pipe stands.
 - 9. Equipment supports.
- B. Related Requirements:
 - 1. Section 230548.13 "Vibration Controls for HVAC" for vibration isolation devices.
 - 2. Section 233113 "Metal Ducts" and Section 233116 "Nonmetal Ducts" for duct hangers and supports.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.
- C. Qualification Data: For testing agency.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless-steel.
2. Outdoor Applications: Stainless steel.

2.3 EQUIPMENT SUPPORTS

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

2.4 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

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

D. Stainless Steel: ASTM A 240/A 240M.

- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use

- operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation:
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. 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.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. 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.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
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 allowed by 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 or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

3.5 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.

3.6 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 a minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099113 "Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 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 carbon-steel pipe hangers and supports and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. 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 up to 1050 deg F, pipes NPS 4 to NPS 24, 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 36, requiring clamp flexibility and up to 4 inches of insulation.

4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. 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 or carbon-steel plate.
 15. 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 or carbon-steel plate, and with U-bolt to retain pipe.
 16. 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.
 17. 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.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. 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 unnecessary.
 20. 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 unnecessary.
 21. 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.
- J. 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 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

- K. 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.
- L. 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-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Elastomeric isolation pads.
 - 2. Elastomeric hangers.
 - 3. Spring hangers.
- B. Related Requirements:
 - 1. Section 220548.13 "Vibration Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- B. Shop Drawings:
 - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 DELEGATED-DESIGN SUBMITTAL

- A. For each vibration isolation device:
 - 1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For testing agency.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data.

1.6 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads: .
 - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
 - 2. Size: Factory or field cut to match requirements of supported equipment.
 - 3. Pad Material: Oil and water resistant with elastomeric properties.
 - 4. Surface Pattern: Smooth or Waffle pattern.
 - 5. Infused nonwoven cotton or synthetic fibers.
 - 6. Load-bearing metal plates adhered to pads.
 - 7. Sandwich-Core Material: Resilient and elastomeric.
 - a. Surface Pattern: Smooth or Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .
 - 1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.3 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.3 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION 230548.13

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Duct labels.
4. Valve tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 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.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:
 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
 2. Letter Color: Blue.
 3. Background Color: White.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 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-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.3 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Blue.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- F. Minimum Letter Size: 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-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.4 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- 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.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Painting."
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
 - 1. Identification Paint: Use for contrasting background.
 - 2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule:
 - 1. Refrigerant Piping: Black letters on a safety-white background.

3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: For cold-air supply ducts.
 - 2. Yellow: For hot-air supply ducts.
 - 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

- C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Refrigerant: 1-1/2 inches, round.
 - 2. Valve-Tag Colors:
 - a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
 - b. Flammable Fluids: Black letters on a safety-yellow background.
 - c. Combustible Fluids: White letters on a safety-brown background.
 - d. Potable and Other Water: White letters on a safety-green background.
 - e. Compressed Air: White letters on a safety-blue background.
 - f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.7 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Systems required to de-rate electrical classification
 - c. Odor Control System
 - d. .
2. Balancing steam systems.
3. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Condensing units.
4. Testing, adjusting, and balancing existing systems and equipment.
5. Sound tests.
6. Vibration tests.
7. Duct leakage tests.
8. Control system verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. TAB Specialists Qualifications: Certified by NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air 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.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.

- I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. 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. Variable-frequency controllers' startup is complete, and safeties are verified.
 - g. Automatic temperature-control systems are operational.
 - h. Ceilings are installed.
 - i. Windows and doors are installed.
 - j. Suitable access to balancing devices and equipment is provided.

3.3 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 Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.

- L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS (supply fans, exhaust fans, packaged AC units, and Odor control)

- 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, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 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 air-handling 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 Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-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, economizer, 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, return, and relief 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. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

E. Odor Control Systems

1. In odorous areas the following additional procedures shall be used in addition to those described above.
2. Odorous areas shall be those areas that are exhausted to odor control system, odor control dispersion stacks, or specifically noted as odorous areas.
3. Balance the exhaust system to the flows shown on the Drawings. Balance the space to maintain a 0.05-in w.g. negative pressure relative to the surrounding areas by adjusting the supply air to the space. If the final supply air quantity is below the flow specified, use this flow and pro-rate it for the various supply air devices, on an equal percentage basis.
4. Balancing shall be done with all doors to the area closed and all interrelated systems operating.
5. After completion of the system balancing the space negative pressures shall be rechecked. If the negative pressures have been reduced, the systems shall be rebalanced to provide the specified negative pressures. This process shall be repeated until the negative pressures are maintained.
6. In addition to the data required above, the following shall be included for odor control systems.
 - a. Required pro-rating of supply systems if any.
 - b. Differential pressure between the odorous space and all adjacent spaces and the out-doors.

3.6 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.

5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record fan and motor operating data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

- B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.9 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. 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.

3.10 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.11 PROGRESS 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: Prepare biweekly progress 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.

3.12 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
 - 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.

2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Engineer's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor 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 terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, 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 including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.

D. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
2. Motor Data:
 - a. Motor 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. Center-to-center dimensions of sheave and amount of adjustments in inches.

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. Filter static-pressure differential in inches wg.
- f. Preheat-coil static-pressure differential in inches wg.
- g. Cooling-coil static-pressure differential in inches wg.
- h. Heating-coil static-pressure differential in inches wg.
- i. Outdoor airflow in cfm.
- j. Return airflow in cfm.
- k. Outdoor-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

E. 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. Outdoor-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 flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.

- n. Refrigerant suction temperature in deg F.
 - o. Inlet steam pressure in psig.
- F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- G. 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. Center-to-center dimensions of sheave and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Motor 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. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.

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.
- H. 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 air-handling-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.
- I. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft..
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- J. Instrument Calibration Reports:

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

3.13 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.
- B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. 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.
- C. If 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."
- D. 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.
- E. If TAB work fails, proceed as follows:
 1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
 2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
 3. If the second verification also fails, Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.
- F. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."
 - 2. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Sheet Form Insulation Materials: 12 inches square.
 - 2. Sheet Jacket Materials: 12 inches square.
 - 3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing 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 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.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Engineer. Use materials indicated for the completed Work.
 - 1. Ductwork Mockups:
 - a. One 10-foot section each of rectangular and round straight duct.
 - b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
 - c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
 - d. One rectangular and round transition fitting.
 - e. Four support hangers for round and rectangular ductwork.
 - f. Each type of damper and specialty.
 - 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 - 3. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
 - 4. Obtain Engineer's approval of mockups before starting insulation application.
 - 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed.

1.6 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.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation 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 C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Knauf Insulation.
 - d. Owens Corning.
- G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Owens Corning.

2.2 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.3 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.
 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 4. Color: White.
- C. Vapor-Retarder Mastic: Solvent based; suitable for indoor use on below ambient services.
 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 2. Service Temperature Range: 0 to 180 deg F.
 3. Color: White.

- D. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 3. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 3. Color: White.

2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Color: White.

2.5 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 4. Color: Aluminum.

2.6 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 C1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
 - 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- B. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
- C. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Width: 3 inches.
 - 2. Thickness: 11.5 mils.
 - 3. Adhesion: 90 ounces force/inch in width.
 - 4. Elongation: 2 percent.
 - 5. Tensile Strength: 40 lbf/inch in width.
 - 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - 1. Width: 2 inches.
 - 2. Thickness: 3.7 mils.
 - 3. Adhesion: 100 ounces force/inch in width.
 - 4. Elongation: 5 percent.
 - 5. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

- A. Bands:
 - 1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

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.
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.
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. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - b. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, 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. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

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

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.11 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. 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.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. 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. 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, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof 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 roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. 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.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- 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 one edge and one 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 two 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 one edge and one 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 two 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- 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.

3.7 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.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.9 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
 - 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.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- 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 Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.10 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 Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
 - 1. Indoor, concealed supply and outdoor air.
 - 2. Indoor, exposed supply and outdoor air.
 - 3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
 - 4. .
- B. Items Not Insulated:
 - 1. Fibrous-glass ducts.
 - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 - 3. Factory-insulated flexible ducts.

4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.
8. Exposed ductwork located in the area it serves.
9. Return air ductwork located in return air ceiling spaces above the area it serves, except where the return ductwork is installed in ceiling spaces with a roof above.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed duct insulation shall be the following:
 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- B. Exposed duct insulation shall be the following:
 1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
 1. None.
- D. Ducts and Plenums, Exposed:
 1. None.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulation for HVAC piping systems.
- B. Related Sections:
 - 1. Section 230713 "Duct Insulation" for duct insulation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - 2. Sheet Form Insulation Materials: 12 inches square.
 - 3. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - 4. Sheet Jacket Materials: 12 inches square.
 - 5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing 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 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.

1.6 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.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- 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 C534/C534M, Type I for tubular materials, Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.

2.2 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. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
 - 1. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 - 2. Wet Flash Point: Below 0 deg F.
 - 3. Service Temperature Range: 40 to 200 deg F.

4. Color: Black.

2.3 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 2. Service Temperature Range: 0 to plus 180 deg F.
 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 4. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.
 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 2. Service Temperature Range: 0 to 180 deg F.
 3. Color: White.
- D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 3. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
 1. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 2. Service Temperature Range: 0 to plus 180 deg F.
 3. Color: White.

2.4 LAGGING ADHESIVES

- A. Adhesive shall comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 2. Service Temperature Range: 20 to plus 180 deg F.
 3. Color: White.

2.5 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 1. Permanently flexible, elastomeric sealant.
 - a. Service Temperature Range: Minus 150 to plus 250 deg F.
 - b. Color: White or gray.

2.6 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 C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.
- B. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-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) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- C. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

2.8 SECUREMENTS

- A. Bands:
1. Stainless Steel: ASTM A240/A240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature of 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 tradesman 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.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of 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 storage, application, and finishing. Replace insulation materials that get wet.
- 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 attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and 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, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 25 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 inches100 mmbeyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof 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 roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. 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.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 4. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's 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 that of pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's 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.
- D. Insulation Installation on Valves and Pipe Specialties:
 1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 3. Install insulation to flanges as specified for flange insulation application.
 4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 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 and for horizontal applications, install with 1-inch overlap at longitudinal seams and end joints. 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-presizes 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.

3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

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.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- 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 Engineer. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections.
- B. Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- F. All insulation applications will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
- B. 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.

3.11 PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- B. Refrigerant Suction and Hot-Gas Piping:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.
- D. Refrigerant Liquid Piping:
 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

END OF SECTION 230719

SECTION 231323 - FACILITY ABOVEGROUND FUEL-OIL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. JEA Water and Sewer Standards Manual Section 472 Emergency Generator (less than 750 KW).
- C. Section 263213.13 - Diesel Engine Driven Generators

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulated, steel, fuel-oil ASTs.

1.3 DEFINITIONS

- A. AST: Aboveground storage tank.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Fuel-oil storage tank accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and ballast pads and anchors, and lifting or supporting points.
 - 2. Indicate dimensions, components, and location and size of each field connection.
 - 3. Shop Drawing Scale: 1/4 inch per foot.

1.5 DELEGATED DESIGN SUBMITTAL

1.6 INFORMATIONAL SUBMITTALS

- A. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are shown and coordinated with other services and utilities.
- B. Qualification Data: For qualified professional engineer.
- C. Seismic Qualification Data: For ASTs, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Brazing certificates.
- E. Welding certificates.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

- A. All work shall conform to the applicable requirements of the city, county, state and federal codes. Where the requirements of such agencies are more stringent than specified herein, abide by such requirements and consider this specification as supplementary to those requirements.
- B. The tank systems including coating and sealants must be accepted by the US Environmental Protection Agency. All work shall conform to the applicable requirements of the following: Federal Register and the Federal Resource Conservation Recovery Act law (RCRA).
- C. All work shall conform to the applicable requirements of the following: National Fire Protection Association (NFPA) 30 - Flammable and Combustible Liquids Code, NFPA 321 - Basic Classification of Flammable and Combustible Liquids, and NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
- D. All work shall conform to the applicable requirements of the following: Department of Environmental Protection, the Florida Building Code, and Local Ordinances.

- E. The tank shall meet the current requirements of Underwriters Laboratories (UL) Standard 142 and UL 2085 and all requirements of the Florida Administrative Code 62-762. All components of the fuel distribution system shall be UL listed, unless otherwise specified, or approved by the Engineer.
- F. The tank and fuel systems shall be designed and fabricated according to best practices and methods available to date.
- G. Electrical Components, Devices, and Accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.
 - 1. Storage Tanks:
 - a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:
 - 1) Structural failures including cracking, breakup, and collapse.
 - 2) Corrosion failure including external and internal corrosion of steel tanks.
 - b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design restraint and anchors for fuel-oil ASTs, and equipment, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

2.2 ABOVEGROUND FUEL OIL STORAGE TANK AND ACCESSORIES

- A. Rectangular Steel Storage Tanks
 - 1. Steel primary and steel secondary tanks shall be listed by UL as an aboveground tank for flammable and combustible liquids and manufactured in accordance with UL 142 and UL Standard 2085 with a two-hour fire rating.
 - 2. The steel primary tanks shall be fabricated from minimum 3/16-inch thick steel plate.
 - 3. Each tank shall be insulated for fire resistance and protected against ballistic and impact penetration.

4. Emergency Vent: as required by NFPA 30 with no size reduction allowed for insulation.
5. Normal Vent: independent of the emergency vent as required by NFPA 30.
6. Steel Tank Openings: threaded and located in the top of tank.
7. Each Steel Tank shall be provided with two (2) lugs for connecting ground conductors for lightning protection in accordance with NFPA 780.
8. Each Steel tank shall be pressure tested at the tank factory at 4 psi per UL 142.
9. Secondary steel tank shall be painted with a primer coat and finish coat of an industrial epoxy coating. The coating shall be impervious to diesel fuel, weather resistant, and UV protected.
10. Secondary containment shall be capable of unobstructed liquid and vapor monitoring. Containment space shall be vacuum or pressure tested pursuant to industry standard.
11. The interstitial space between inner and outer tanks shall be filled with light weight thermal insulation or reinforced concrete.
12. Leak detection shall be facilitated by a polyethylene membrane around the primary tank or porous fill material.
13. Integral steel supports shall be provided for each tank.
14. Each tank shall have appropriate warning signs as required by the local and state jurisdictions.
15. Each steel tank shall have an integral seven-gallon UL listed spill containment system, as a part of the tank, with internal reservoir and normally closed UL listed drain port. Spill containment system shall be provided with water tight gaskets at all openings. This includes containment housing cover, fill port cover, drain valve, and stick port cover.
16. Each tank shall be placed on reinforced concrete pad made to manufacturer's specifications.
17. Hurricane Restraints and Flood Restraints shall be designed and installed per the requirements of the Florida Building Code with Amendments. Design services shall be provided by a licensed Engineer as described in Paragraph 1.06. Signed and sealed calculations shall be submitted for record purposes.
18. The tank design shall have been in manufacturing production and commercial use for a minimum of five (5) years.
19. The tanks shall be Envirovault as manufactured by Phoenix Products, Convault or Fidelity Manufacturing.
20. Tank size shall be 3000 gallons.
21. The fuel tanks shall be left 90 percent full of diesel fuel at the conclusion of the contract as part of the Contractor Scope of Services. Refer to Paragraph 3.05.D.

B. Tank Accessories

1. A mechanical level gauge system shall be provided to indicate the liquid level within the tank. The level gauge shall have a direct reading indicator mounted on top of the tank. The tank shall include all openings required for the level gauge system. Gauge shall be Krueger At-A-Glance Type D Direct Reading Gauge.
2. A mechanical leak gauge system shall be provided to indicate leaks in the annular/interstitial space of the double wall above ground fuel tank. The leak gauge shall have a direct reading indicator mounted on top of the tank. The tank shall include all openings required for the leak gauge system. Gauge shall be Krueger Type D Leak Detection Gauge.
3. Provide stairs with 24" x 24" platform at the top, to provide access to the top of the tank. Stairs shall have handrails on both sides and at all platform sides. Stairs shall be aluminum construction and painted with one coat of epoxy corrosion resistant paint, color to be selected by the Owner. Refer to the Drawings for required location of stairs for each tank.
4. The tank fabricator shall provide ports and accessories with the tank as shown on the drawings and listed below.
5. All ports shall be steel pipe with male threaded fittings.
6. All ports except for those with capped accessories shall be provided with threaded caps.
7. The following equipment shall be furnished along with the necessary piping and fittings required to provide a complete diesel fuel piping system.
 - a. Vent piping shall be 3-inches.
 - b. Vent cap shall be 3-inches and shall be constructed of aluminum with removable brass screen, EBW Model 800-203-01.
 - c. A single poppet foot valve, EBW model 75-105-01 shall be installed inside the aboveground tank at the fuel intake line at a location 6" above the bottom of the tank.

C. Fuel Level/Leak Monitoring Equipment

1. General
 - a. Each tank will be furnished with a complete electrical monitoring system and associated equipment including but not limited to tank alarm, tank level detection and real time monitoring, tank leak detection, and associated modules for the entire fuel level/leak detection system shown on the drawings and specified herein. The system shall be the Greenleaf Solar Gauge EFG-8000-I with EFC-420.1 4-20mA data converter. The system shall include provisions for remote monitoring of the alarm conditions, tank level detection, and tank leak detection including all required terminals, switches, and transmitters.
 - b. The control unit shall be housed in a NEMA 4 equivalent plastic steel enclosure. All probes and sensors shall be rated for outdoor service.
 - c. The control unit shall be solar powered with battery back-up.
 - d. A minimum of four (4) programmable relay outputs shall be provided. At least one output shall be designated as a common system alarm/fault. The tank level shall be provided with a 4-20 mA outputs for level monitoring each tank at a remote monitoring PLC. Tank manufacturer shall coordinate with the Instrumentation System Supplier to provide all required signals for the Instrumentation System. Refer to instrumentation drawings for additional signal requirements.
 - e. The supplier shall be responsible for coordinating and providing all necessary components for a fully functional fuel level and leak detection monitoring system. Any addi-

- tional components required for a complete system shall be included whether specifically noted or not.
- f. Provide complete piping and electrical schematic diagrams for the entire system in the shop drawing submittals.
2. Tank Level/Leak Detection
 - a. All necessary tank level and leak detection probes shall be provided. The system shall include provisions for remote monitoring of the level detection system including all required terminals, switches, transmitters, and local wiring.
 3. Double Wall Interstitial Leak Sensing
 - a. Double wall interstitial leak sensing shall be capable of detecting the presence of any liquid in the annulus of the aboveground storage tanks.
 4. Tank Alarm Horn and Light

A LOCAL AUDIBLE ELECTRONIC HORN AND FLASHING AMBER LIGHT ALARM SYSTEM SHALL BE FURNISHED TO INDICATE A TROUBLE CONDITION. HORN AND LIGHT SHALL BE NEMA 4 SUITABLE FOR OUTDOOR INSTALLATIONS. 2.3 PIPE AND FITTINGS AND FUEL SYSTEM ACCESSORIES

- A. Piping, all above-grade fuel, vent, and level gauge piping shall be Schedule 40, Type 316 stainless steel welded in conformance with ASTM A-312 and ASTM A-774 stainless steel socket and butt weld fittings.
- B. Flexible piping at tank and equipment connections shall be constructed of a seamless flexible plastic liner with corrosion resistant type 316 stainless steel wire braid reinforced cover, stainless steel collars, and stainless steel fittings meeting SAE 100R17 requirements.
- C. Metallic marking tape shall be laid above all underground piping as shown on the Drawings for the purpose of identification with a metal detector. Tape shall be 6 inches wide, fully detectable, with a minimum 5.0 mil overall thickness. Tape shall be manufactured using a 0.8 mil clear virgin polypropylene film, reverse printed and laminated to a 0.35 mil solid aluminum foil core, and then laminated to a 3.75 mil clear virgin polyethylene film. Tape shall be printed using a diagonally striped design for maximum visibility, and meet the APWA Color-Code standard for identification of buried utilities. Detectable marking tape shall be Pro-Line Safety Products or Approved Equal.
- D. Provide all piping, valves, unions, filters, strainers, and other accessories as shown on the Drawings and/or as required for a complete system.
 1. Fire safe ball valves shall be three-piece design with stainless steel body and end caps, stainless steel ball and stem, reinforced Teflon seats and seals, and socket welded ends. Valves shall be of fire safe design and shall utilize secondary metal seating surfaces to ensure shut-off if the primary seats are destroyed by fire. Fire safe ball valves shall be Con-tromatics or Jamesbury.
 2. An anti-siphon valve, EBW model 605-300-01 shall be installed at the aboveground tank in the fuel intake line, at a location approximately 6" above the top of the tank, or as required by the valve manufacturer. Valve shall be suitable for the final elevations of the aboveground tank and generator as installed.

3. Unions shall be Type 316 stainless steel with fully ground faces. Where threaded unions are required, all threaded connections shall utilize Hercules Chemical Company Inc. multi-purpose heavy Teflon "Tape Dope" and "Megalog and/or Real-tuff."
 4. Manual strainers shall be "Y" type, capable of removing solids 0.01-inch diameter and larger. The strainer body shall be Type 316 stainless steel construction, and shall conform to the latest revision of ASTM A278 (1993), Class 30. Strainer elements, including woven wire mesh, shall be constructed of stainless steel. The design of the strainer body shall be such that the cleanout plug and screen may be easily removed to permit inspection and cleaning without disassembly of the inlet and outlet piping. End connections shall be ANSI screwed pipe threads. Provide three spare screen elements for each strainer furnished. The strainers shall be designed for a maximum operating pressure of 150 psig. They shall be as manufactured by GA Industries Inc., Pittsburgh, PA or approved equal.
 5. Refer to Section 16216 for fuel filter and oil water separator.
- E. All piping and supports that are installed outdoors shall be designed and installed to meet wind loadings as required by the Florida Building Code, all other applicable codes, and the requirements of this specification. Design services shall be provided by a licensed Engineer as described in Paragraph 1.06. Signed and sealed calculations shall be submitted for record purposes.
- F. All piping and tank supports, including hangers, brackets, fasteners, and miscellaneous metals shall be Type 316 Stainless Steel.
- G. Joint compound for steel pipe threaded connections shall be a non-hardening, non-solvent joint sealer.
- H. Fire Suppression Kits:
1. Contractor shall furnish a packaged fire suppression kit including 10 lb. extinguisher with vinyl jacket.
- I. Provide a Core Engineered Solutions Spill Kit, Model EP-SKL-2, Or Equal, including socks, pillows, wipers, mat pads, labels, Emergency Response Guidebook, and instruction manual.
- J. Finish painting shall be provided as specified in Division 9 - Finishes and as specified herein.
1. Tank exterior shall be factory painted prior to shipment. Painting shall be two coats of epoxy powder coating suitable for outdoor corrosive environment and approved by Owner.
 2. All non-stainless steel pipe fittings and nipples on the tank shall have a suitable primer and finish coat of epoxy powder coating suitable for outdoor corrosive environment and approved by Owner.
 3. All colors to be selected by the Owner.
 4. The Contractor shall provide minor field touch-up painting of fuel tank after completed installation. Surface preparation shall be in accordance with factory paint system. Any major defects or damage shall be inspected and repaired by the Manufacturer.
 5. One quart of paint and a brush shall be provided to the Owner for field touchup painting.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Comply with requirements in Section 312000 "Earthwork" for excavating, trenching, and backfilling.
- B. Allow for cast-in-place, concrete base.

3.3 FUEL-OIL AST INSTALLATION

- A. Install tank bases and supports.
- B. Concrete Bases: Anchor AST to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 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. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."
- C. Connect piping and vent fittings.
- D. Install ground connections.
- E. Install tank leak-detection and monitoring devices.
- F. Install steel ASTs according to STI R912.
- G. Install insulated and concrete-vaulted, steel ASTs according to STI R942.
- H. Fill storage tanks with fuel oil.

3.4 LIQUID-LEVEL GAGE SYSTEM INSTALLATION

- A. Install liquid-level gage system. Install panel inside building where indicated.

3.5 LABELING AND IDENTIFYING

- A. Nameplates, pipe identification, and signs are specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.6 FIELD PAINTING OF AST

- A. Prepare and touch up damaged exterior surface of AST and supports as specified in "Shop Painting of AST" Article.
- B. Prepare exterior steel surface of AST and tank supports.
- C. After cleaning, remove dust or residue from cleaned surfaces.
- D. If surfaces develop rust before prime coat is applied, repeat surface preparation.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
 - a. Single-Wall Tanks: Minimum 3 psig and maximum 5 psig.
 - b. Double-Wall Tanks:
 - 1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
 - 2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.
 - c. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
 - d. Maintain the test pressure for one hour.
- C. ASTs will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 231323

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Refrigerant pipes and fittings.
 - 2. Refrigerant piping valves and specialties.
 - 3. Refrigerants.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve, refrigerant piping, and piping specialty.
 - 1. Include pressure drop, based on manufacturer's test data, for the following:
 - a. Thermostatic expansion valves.
 - b. Solenoid valves.
 - c. Hot-gas bypass valves.
 - d. Filter dryers.
 - e. Strainers.
 - f. Pressure-regulating valves.
- B. Shop Drawings:
 - 1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
 - 2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
 - 3. Show interface and spatial relationships between piping and equipment.
 - 4. Shop Drawing Scale: 1/4 inch equals 1 foot.
 - 5. Submit letter of acceptance for the refrigeration system design by the equipment manufacturer or their authorized representative.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.
- C. Total weight, type and number of refrigerant in system(s).

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: ASTM B88, Type K or L or ASTM B280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.

- D. Solder Filler Metals: ASTM B32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8/A5.8M.
- F. Flexible Connectors:
 - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
 - 2. End Connections: Socket ends.
 - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
 - 4. Working Pressure Rating: Factory test at minimum 500 psig.
 - 5. Maximum Operating Temperature: 250 deg F.
- G. Service Valves:
 - 1. Body: Forged brass with brass cap including key end to remove core.
 - 2. Core: Removable ball-type check valve with stainless-steel spring.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Copper spring.
 - 5. Working Pressure Rating: 500 psig.
- H. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
 - 1. Body and Bonnet: Plated steel.
 - 2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Threaded.
 - 5. Working Pressure Rating: 400 psig.
 - 6. Maximum Operating Temperature: 240 deg F.
- I. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
 - 1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 - 2. Piston, Closing Spring, and Seat Insert: Stainless steel.
 - 3. Seat: Polytetrafluoroethylene.
 - 4. End Connections: Threaded.
 - 5. Working Pressure Rating: 400 psig.
 - 6. Maximum Operating Temperature: 240 deg F.
- J. Thermostatic Expansion Valves: Comply with AHRI 750.
 - 1. Body, Bonnet, and Seal Cap: Forged brass or steel.
 - 2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 - 3. Packing and Gaskets: Non-asbestos.
 - 4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 - 5. Suction Temperature: 40 deg F.
 - 6. Reverse-flow option (for heat-pump applications).
 - 7. End Connections: Socket, flare, or threaded union.
 - 8. Working Pressure Rating: 450 psig.

K. Straight-Type Strainers:

1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

L. Angle-Type Strainers:

1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

M. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

N. Permanent Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Designed for reverse flow (for heat-pump applications).
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: 2 psig.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

O. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with soldered joints.
- B. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- C. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - 1. NPS 5/8 and Smaller: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.
 - 2. NPS 3/4 to NPS 1 and Smaller: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
 - 1. Install valve so diaphragm case is warmer than bulb.
 - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
 - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs (a properly sized refrigerant riser may be used if only on/off compressor operation is used).
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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

- C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook."
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
 - 1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
 - 2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.
- F. Threaded Joints: Thread steel 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 to 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. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic restraints in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
- C. Suction line hangers shall be sized for pipe insulation outside diameter.
- D. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
 - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

- E. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- F. Support horizontal piping within 12 inches of each fitting.
- G. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Comply with ASME B31.5, Chapter VI.
 - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
 - 3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.
 - a. Fill system with nitrogen to the required test pressure.
 - b. System shall maintain test pressure at the manifold gage throughout duration of test.
 - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
 - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.
- B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

- A. Charge system using the following procedures:
 - 1. Install core in filter dryers after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
 - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
 - 4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
 - 1. Open shutoff valves in condenser water circuit.
 - 2. Verify that compressor oil level is correct.
 - 3. Open compressor suction and discharge valves.
 - 4. Open refrigerant valves except bypass valves that are used for other purposes.
 - 5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.
5. Seismic-restraint devices.

- B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

- A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

- B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For sealants, indicating VOC content.
4. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

5. Laboratory Test Reports: For antimicrobial coatings, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of all 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. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Welding certificates.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- E. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - 1. Construct ducts of Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
 - 2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
 - 3.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: 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. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- C. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- D. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches.
- E. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
 - 1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
 - 2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
 - 3. Butt transverse joints without gaps, and coat joint with adhesive.
 - 4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
 - 5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
 - 6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
 - 7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
 - 8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
 - 9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
 - 10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.4 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 3 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
 7. Service: Indoor and outdoor.
 8. Service Temperature: Minus 40 to plus 200 deg F.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 10. Sealant shall have a VOC content of 420 g/L or less.
 11. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Solids Content: Minimum 65 percent.
 3. Shore A Hardness: Minimum 20.
 4. Water resistant.
 5. Mold and mildew resistant.
 6. VOC: Maximum 75 g/L (less water).
 7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
 8. Service: Indoor or outdoor.
 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
 2. Base: Synthetic rubber resin.
 3. Solvent: Toluene and heptane.
 4. Solids Content: Minimum 60 percent.
 5. Shore A Hardness: Minimum 60.
 6. Water resistant.
 7. Mold and mildew resistant.
 8. Sealant shall have a VOC content of 420 g/L or less.
 9. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of

Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
1. Sealant shall have a VOC content of 420 g/L or less.
2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.
- B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install ducts in maximum practical lengths with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- J. Install fire and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.
- K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

- M. Elbows: Use long-radius elbows wherever they fit.
 - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
 - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.
- N. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.

12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
 - 5. Test for leaks before applying external insulation.
 - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 - 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
 - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.8 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
- B. For cleaning of existing ductwork, see Section 230130.52 "Existing HVAC Air Distribution System Cleaning."
- C. Use duct cleaning methodology as indicated in NADCA ACR.
- D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components 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, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. 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, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.9 STARTUP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 - 1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.
- B. Ducts:
 - 1. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- C. Intermediate Reinforcement:
 - 1. Aluminum Ducts: Aluminum.
- D. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Conical spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Control dampers.
 - 3. Turning vanes.
 - 4. Remote damper operators.
 - 5. Flexible connectors.
 - 6. Duct accessory hardware.
- B. Related Requirements:
 - 1. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. 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.

2.2 MATERIALS

- A. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- B. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
- E. Standard, Aluminum, Manual Volume Dampers:
 - 1. Standard leakage rating, with linkage outside airstream.
 - 2. Suitable for horizontal or vertical applications.
 - 3. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 4. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.

- d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 - 5. Blade Axles: Stainless steel.
 - 6. Bearings:
 - a. Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 7. Tie Bars and Brackets: Aluminum.
- F. Low-Leakage, Aluminum, Manual Volume Dampers:
 - 1. Comply with AMCA 500-D testing for damper rating.
 - 2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Angle-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 - 6. Blade Axles: Stainless steel.
 - 7. Bearings:
 - a. Oil-impregnated stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Blade Seals: Neoprene.
 - 9. Jamb Seals: Cambered stainless steel.
 - 10. Tie Bars and Brackets: Aluminum.
 - 11. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- G. Jackshaft:
 - 1. Size: 0.5-inch diameter.
 - 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

H. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.3 TURNING VANES

- A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Double wall.
- E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.4 FLEXIBLE CONNECTORS

- A. Materials: Flame-retardant or noncombustible fabrics.
- B. Coatings and Adhesives: Comply with UL 181, Class 1.
- C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
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.
- E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: 24 oz./sq. yd..
 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 3. Service Temperature: Minus 50 to plus 250 deg F.

- F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd..
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd..
 - 2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of the 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.5 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 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. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch- diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
- I. Connect ducts to duct silencers with flexible duct connectors.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

M. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

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

Q. Connect flexible ducts to metal ducts with draw bands.

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

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-insulated flexible ducts.
 - 2. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For flexible ducts.
 - 1. Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. 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.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

- D. Comply with ASTM E 96/E 96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

- A. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 20 to plus 210 deg F.
 - 4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

2.3 FLEXIBLE DUCT CONNECTORS

- A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
- B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts 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. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.
- C. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- D. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with draw bands.
- F. Install duct test holes where required for testing and balancing purposes.
- G. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 - 5. Install flexible ducts in a direct line, without sags, twists, or turns.

H. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Axial roof ventilators.
2. Centrifugal ventilators - roof upblast and sidewall.
3. Utility set fans.

1.3 ACTION SUBMITTALS

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

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

- B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

- B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Capacities and Characteristics: Refer to HVAC Drawings

2.2 AXIAL ROOF VENTILATORS

- A. Housing: Heavy-gauge, removable, spun-aluminum dome top and outlet baffle; square, one-piece, hinged, aluminum base.
- B. Fan Wheel: FRP hub and blades. Sparkproof construction.
- C. Belt Drives:
 - 1. Resiliently mounted to housing.
 - 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 - 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 - 4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.

D. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Stack hood with built-in backdraft dampers.
6. Extended lubrication lines.

2.3 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

A. Configuration: Centrifugal roof upblast or sidewall ventilator.

B. Housing: Removable spun-aluminum dome top and outlet baffle or FRP; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades; sparkproof construction (refer to schedules).

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
6. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.

7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Wall Mount Adapter: Attach wall-mounted fan to wall.
9. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.

2.4 UTILITY SET FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, [**belt-**] [**direct-**]driven centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

B. Housings:

1. Housing Material: See schedule.
2. Housing Coating: See schedule.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of seven discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: See schedule.
 - a. Spark-Resistant Construction: Classified according to AMCA 99, See schedule.
3. Wheel and Blade Coating: See schedule
4. Backward-Inclined Airfoil Blades:
 - a. Aerodynamic design.
 - b. Heavy backplate.
 - c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
5. Backward-Inclined Curved Blades:
 - a. Curved design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
6. Backward-Inclined Flat Blades:
 - a. Flat design.
 - b. Heavy backplate.
 - c. Single-thickness blades continuously welded at tip flange and backplate.
7. Forward-Curved Blades:

- a. Curved design.
- b. Heavy backplate.
- c. Single-thickness blades continuously welded or riveted at tip flange and backplate.

D. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

E. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast iron pillowblock housing.
2. Ball-Bearing Rating Life: ABMA 9, L(50) of 200,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L(50) of 200,000 hours.
4. Extend grease fitting to accessible location outside of unit.

F. Belt Drive:

1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size: 1.5.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," 0.146 inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

G. Motor Enclosure: See schedule

H. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Outlet Screens: Removable wire mesh.
8. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
10. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
11. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.

12. Discharge Dampers: See schedule.
13. Grease Collection Trough and Receiver: For restaurant exhaust application.
14. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.5 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.6 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.
- B. Equipment Mounting:
 1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

- C. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 077200 "Roof Accessories" for installation of roof curbs.
- D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- E. Support suspended units from structure using threaded steel rods and elastomeric hangers or spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Section 230548.13 "Vibration Controls for HVAC."
- F. Install units with clearances for service and maintenance.
- G. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:
 - 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 there is adequate maintenance and access space.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 6. Adjust belt tension.
 - 7. Adjust damper linkages for proper damper operation.
 - 8. Verify lubrication for bearings and other moving parts.
 - 9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 11. Shut unit down and reconnect automatic temperature-control operators.
 - 12. Remove and replace malfunctioning units and retest as specified above.
- F. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. High-capacity drum louver diffusers.
- B. Related Requirements:
 - 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
 - 2. Section 233713.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 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 Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.
- C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.
- D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension 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.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

- A. Devices shall be specifically designed for variable-air-volume flows.
- B. Material: Aluminum.
- C. Finish: Baked enamel, white.
- D. Face Size: 24 by 24 inches.
- E. Face Style: Four cone.
- F. Mounting: T-bar Spline.
- G. Pattern: Fixed Adjustable.
- H. Dampers: Radial opposed blade.
- I. Accessories:
 1. Equalizing grid.
 2. Plaster ring.
 3. Safety chain.
 4. Wire guard.
 5. Sectorizing baffles.
 6. Operating rod extension.

2.2 HIGH-CAPACITY DRUM LOUVER DIFFUSERS

- A. Airflow Principle: Extended distance for high airflow rates.
- B. Material: Aluminum, heavy gage extruded.
- C. Finish: White baked acrylic.
- D. Border: 1-1/4-inch width with countersunk screw holes.
- E. Gasket between drum and border.
- F. Body: Drum shaped; adjustable vertically.
- G. Blades: Individually adjustable horizontally.

- H. Mounting: Surface to duct or wall.
- I. Inlet Width: **refer to plans.**
- J. Inlet Length: **refer to plans.**
- K. Accessories:
 - 1. Opposed-blade steel damper.
 - 2. Duct-mounting collars with countersunk screw holes.

2.3 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers 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 practical. 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 Engineer for a determination of final location.
- C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

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

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Adjustable blade face registers and grilles.
- 2. Fixed face registers and grilles.

- B. Related Requirements:

- 1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
- 2. Section 233713.13 "Air Diffusers" for various types of air diffusers.

1.3 ACTION SUBMITTALS

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

- 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. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

- B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.

- C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Smallest size register and grille indicated.

- D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Smallest size register and grille indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

- 1. Ceiling suspension 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.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS

- A. Adjustable Blade Face Register:
1. Material: Aluminum.
 2. Finish: Baked enamel, white.
 3. Face Blade Arrangement: Vertical spaced 1-1/2 inches apart.
 4. Core Construction: Integral.
 5. Rear-Blade Arrangement: Horizontal spaced 3/4 inch apart.
 6. Frame: 1-1/4 inches wide.
 7. Mounting: Lay in.
 8. Damper Type: Adjustable opposed blade.
 9. Accessories:
 - a. Rear-blade gang operator.
 - b. Filter.

2.2 GRILLES

- A. Adjustable Blade Face Grille:
1. Material: Aluminum.
 2. Finish: [**Baked enamel, white**] Baked enamel, color selected by Engineer.
 3. Face Blade Arrangement: Horizontal spaced 1-1/2 inches apart.
 4. Core Construction: Integral.
 5. Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
 6. Frame: 1-1/4 inches wide.
 7. Mounting: Lay in.
 8. Accessories:
 - a. Rear-blade gang operator.
 - b. Filter.

2.3 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: 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 practical. 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 Engineer for a determination of final location.
- C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

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

END OF SECTION 233713.23

SECTION 238126 - SPLIT-SYSTEM AND PACKAGED AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.
 - 3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 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:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: One year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation; a unit of United Technologies Corp.
 2. Trane.

2.2 INDOOR UNITS (5 TONS OR LESS)

- A. Floor-Mounted, Evaporator-Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Engineer.
 - a. Insulation: Faced, glass-fiber duct liner.
 - b. Drain Pans: Galvanized steel, with connection for drain; insulated.
 2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
 3. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
 4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
 5. Fan: Direct drive, centrifugal.
 6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 7. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum MERV according to ASHRAE 52.2.
 - 3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b. Disposable Panel Filters:
 - 1) Factory-fabricated, viscous-coated, flat-panel type.

- 2) Thickness: Refer to HVAC Schedules on the Drawings
- 3) MERV according to ASHRAE 52.2: 8.
- 4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
- 5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Engineer, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.4 PACKAGED AIR CONDINTIONING UNITS

- ### A. In general, all packaged make-up air units shall be factory assembled with cabinet fan, heating and/or cooling section, filters, dampers, access sections with hinged access doors, motor, motor base, drive, drive guard and vibration isolators.
1. Units shall be designed to provide an integrated assembly when all of the components are assembled. All transition sections and filler pieces required between sections are to be provided as part of the unit.
 2. Support brackets or rails are to be provided with the unit. Type of support is to be as required by the schedules and as shown on the Drawings, e.g. hung, floor mounted, etc. All air handling units shall be provided with lugs, brackets or field supplied devices to allow the unit to be firmly bolted to the structure or fastened to specified vibration isolators. The lugs, brackets or field supplied devices shall be sized to withstand the expected seismic loads for the area and type of application. Location of the attachments shall be based on the equipment being hung or base mounted as shown on the Drawings and the schedules.

3. Self-contained package units shall also contain compressors, refrigerant piping system, condenser, condenser fans and drives, mounting curb and factory wired control panel.
4. Heat pump units shall use a refrigerant system for both heating and cooling. Units shall include reversing valves and defrost controls.
5. Units not mounted on vibration isolators shall have all rotating components internally isolated from the main unit with vibration isolators.
6. Ductwork connections to units that require corrosion resistant coatings shall be made with flanges. Flanges shall be factory drilled before coating. Resilient washers suitable for the environment shall be used to protect the coating from the bolts in the flange. The use of self tapping screws or other fastening methods that will damage the coating are not acceptable.

B. Casings

1. Casings shall be galvanized sheet steel construction with structural framing members as required. Pressure class rating shall be for the total fan static pressure. All sections of the unit shall be of the same pressure class.
2. The housing shall be constructed of formed and reinforced metal panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed and continuous seam welded corners. Unit shall be double-wall construction with insulation sandwiched between the panels. Provide with structural framing as required. Interior of unit shall be flush with no internal standing seams or framing extending into the air stream. Seal all seams with high performance polyurethane sealant. Materials of construction shall be as called for in the schedules. The housing shall be coated internally and externally with a gray polyurethane enamel for corrosion resistance. Pressure class rating shall be for the total fan static pressure. All sections of the unit shall be of the same pressure class.
3. Where specified on the schedules, and in all units with heating and/or cooling sections, the unit shall be insulated. All sections including, but not limited to, return plenum, coils, filter, spacers, access sections, fan cabinet, mixing box and by-pass sections, shall be insulated. Insulation shall be 1-in mat faced or neoprene coated fiberglass liner, 1-1/2 pound minimum density, installed with stick clips and adhesives to prevent erosion of the insulation.
4. Provide gasketed access doors for servicing all components. Access doors shall have a positive-pressure locking latch to provide an airtight seal. Bolts, nuts and shafts for door latches, handles and hinges shall be stainless steel.
5. Where suspended from structure, horizontal units shall be supported on channel supports or provided with brackets.
6. Holes shall be provided in the base rails for rigging shackles to facilitate overhead rigging and forklift slots shall be provided to facilitate maneuvering.
7. Units for outdoor installation shall comply with the following:

- a. Materials of construction shall be corrosion resistant, or provided with a corrosion resistant coating system for weather protection.
- b. The casing shall enclose all components for weather protection, with gasketed access doors provided for all sections to facilitate maintenance. Doors shall have provision for key locking to prevent unauthorized tampering.
- c. Top of housing shall be constructed to prevent buckling and ponding of water.

C. Fan Section

1. Fans shall be centrifugal cabinet fans with belt or direct drive as scheduled. Extended external lubrication fittings shall be provided.
2. On belt driven fans, mount motor on an adjustable slide base, equipped with jack screws.
3. Where scheduled, backwardly curved wheels shall be air foil type.
4. All fans shall be statically and dynamically balanced before shipment.
5. Whenever possible, fans shall be AMCA certified for sound and air performance, per AMCA 210-85 and AMCA 330-86.
6. Where called for on the schedules, fans shall be of spark resistant construction. On spark resistant fans, bearings shall not be placed in the air stream. Construction shall conform to AMCA 99-0401-82 Classification.
7. Fan bearings shall be furnished as specified elsewhere in this Section.

D. Cooling Section

1. Cooling coil section shall be insulated, and provided with drain pan, coil support slide rails and coil closure plate. Coil mounting shall minimize air by-pass around the coil. Provide insulated drain pan with a corrosion resistant lining and drain connections on both ends of the drain pan.
2. Refrigerant cooling coils shall be cartridge type with copper tubes, aluminum fins, galvanized steel frame, copper suction header and distribution tubes. Fins shall be mechanically attached to the tubes. Coils shall be pressure and leak tested at 300 psig with air under water. Coils shall be certified per ARI Standard 410.

E. Heating Sections

1. Heating section shall be insulated. Where heating is provided by coils, coil support slide rails and closure plates shall be provided.
2. Location of heating sections, preheat and reheat, shall be as shown on the schedules or Drawings.
3. Indirect gas fired heating sections shall have a minimum efficiency as defined by ASHRAE Standard of Energy Conservation in New Building Design. Heater section shall be insulated and shall have radiation shields. Heat exchanger and combustion chamber shall be gastight continuous welded construction stainless steel.

- a. The gas burner shall be equipped with spark ignited gas pilot, safety control automatic gas valve, main gas regulator, pilot regulator and cock and all components for a complete burner. The unit shall have all required burner and safety controls. Burner control and fuel piping train shall conform to FM requirements.
 - b. Factory wired controls shall be provided in the unit control panel. Panel shall include all safety controls and interlocks, control devices, and terminal strip for remote wired devices. Control type shall be as specified in the schedules. Control voltage shall not exceed 120 Volt.
 - c. Where called for on the equipment schedules, units shall be provided with powered venting or powered venting and combustion air ducting to the outdoors. Units shall include a power venter motor and wheel. A pressure sensor shall be provided to confirm operation of the power venter before operation of the unit is allowed.
4. Direct gas fired heating section shall be used only on units with 100 percent outdoor air. Burner shall operate directly in the air stream with flame spread across the air stream.
 - a. Burners shall be equipped with spark ignited gas pilot, safety control automatic gas valve, main gas regulator, pilot regulator and cock and all components for a complete burner. The unit shall have all required burner and safety controls, to include air flow interlock. Burner control and fuel piping train shall conform with FM requirements.
 - b. Factory wired controls shall be provided in the unit control panel. Panel shall include all safety controls and interlocks, control devices, and terminal strip for remote wired devices. Control type shall be as specified in the schedules. Control voltage shall not exceed 120 Volt.

F. Filters

1. See makeup and air handling unit schedules for filter types by unit.
2. Filter Box shall have tracks for the specified filter types, except roll filters, to allow filter replacement from either side. Sealing material shall be provided at tracks and ends to prevent air by-passing the filters.
3. Disposable Filters for Electrical Room units shall be framed filters, 1-in or 2-in thickness (as scheduled). Filter pressure drop for clean filters at 300 fpm face velocity shall be 0.2-in wg for 1-in thick and 0.15-in wg for 2-in thick filters. Filter shall have 30 to 35 percent efficiency on ASHRAE test standard 52-76. Manufacturers and type shall be American Air Filter Co., Am Air 300X; Camfil Farr Co., 30/30 Disposable or equal.
4. A total of three complete sets of filter media shall be provided for each unit.

G. A complete refrigerant piping system shall be factory fabricated and installed in the unit. Each compressor shall be provided with a complete and independent refrigerant piping system.

1. Piping shall be Type K copper tubing with joints silver brazed. Brazing shall be done with an inert gas purge. Suction lines shall be insulated with closed cell foam insulation. Hot gas piping shall be insulated to protect personnel as required.
2. Valves shall be bronze body brazed connection and shall include compressor and condenser relief valves, condenser liquid line service valve, refrigerant charging valve, compressor discharge, suction service valves, liquid line solenoid and thermal expansion valve.

3. Complete refrigerant system shall be cleaned, leak tested and charged with refrigerant.

H. Unit Control Panel

1. For self-contained package units, split systems and fuel burning units, factory wired control panel shall be furnished and mounted on the unit. Panels shall include all controls required in other sections and all safety controls and interlocks, heavy duty fused visible break disconnect, control devices, motor starters and terminal strip for remote wired devices. Control type and sequence shall be as specified in other related Sections or on the Drawings. Control voltage shall not exceed 120 Volts. Control panel door shall be provided with a keyed lock. A complete wiring diagram shall be permanently attached to the inside of the panel door. Step control sensors and step controller will be provided under the temperature control portion of the specification unless specified with unit on the equipment schedule.
2. Furnish electric heater section controls as scheduled and in accordance with the controls specified under Electric Duct Heaters, elsewhere in this Section.
3. Where specific area classifications are called for or shown on the electrical drawings, all equipment and wiring shall be in conformance with the requirements for that classification.
4. The type of enclosure shall be as specified in Division 16.

I. Accessory Sections

1. Accessory sections shall be as shown on the Drawings and Schedules, and as required for the unit type.
2. Furnish aluminum or steel dampers in accordance with requirements specified under ATC Equipment elsewhere in this Section. Mixing box dampers shall be parallel blade type and where dampers are used for outdoor air shutoff service, they shall be low leakage type. Manual dampers shall be provided with an external position indicating handle with a positive locking device.
3. Dampers shall be opposed blade type with blades mounted on 1/2-in minimum steel rods. Dampers shall be provided with low friction bushings and edge gaskets to reduce air leakage. Blades shall be sectionalized to limit unsupported blade length and warping at full system fan static pressures. Maximum damper blade width shall not exceed 6-in. Manual dampers shall be provided with an external position indicating handle with a positive locking device.
4. Mixing boxes shall be of the configuration shown on the Drawings. Deflection plates shall be provided if required to maintain even air flow over coils and prevent stratification.
5. The dampers for all units that require corrosion resistant coatings shall be constructed of corrosion resistant materials and will not be coated. Materials and construction shall be as specified for control dampers in under this Section, and as required for the ductwork materials the unit is connected to.

6. The dampers for all units that require corrosion resistant coatings shall be supplied under this Section. Materials and construction shall be as required for the ductwork materials to which the unit is connected.
7. Spacer and access sections will be provided where specified or required. Access sections shall have hinged doors on each end except for filters.
8. Factory fabricated insulated curbs shall be provided where shown on the schedule and/or Drawings. Curbs shall be galvanized steel construction with corrosion resistant coating. Unless otherwise specified, curbs shall include provisions for supply and return air duct and piping connections to the area below. Where the roof is pitched the curb shall be constructed to match the pitch and provide a level surface at the top of the curb for the unit to mount on.

2.5 ACCESSORIES

- A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
 1. Compressor time delay.
 2. 24-hour time control of system stop and start.
 3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
 4. Fan-speed selection including auto setting.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- E. Drain Hose: For condensate.
- F. Monitoring:
 1. Monitor constant and variable motor loads.
 2. Monitor variable-frequency-drive operation.
 3. Monitor economizer cycle.
 4. Monitor cooling load.
 5. Monitor air distribution static pressure and ventilation air volumes.

2.6 CAPACITIES AND CHARACTERISTICS: Refer to HVAC Drawings

PART 3 - EXECUTION

3.1 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 roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
 - 3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 4. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 1. Water Coil Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
 - 2. Remote, Water-Cooled Condenser Connections: Comply with requirements specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties." Connect hydronic piping to supply and return connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

- C. 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."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. 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.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Removal of existing electrical equipment, wiring, and conduit in areas to be remodeled; removal of designated construction; dismantling, cutting and alterations for completion of the Work.
2. Disposal of materials.
3. Storage of removed materials.
4. Identification of utilities.
5. Salvaged items.
6. Protection of items to remain as indicated on Drawings.
7. Relocate existing equipment to accommodate construction.

- B. Related Sections:

1. Section 024116 - Structure Demolition: Demolition of utilities and other underground items.
2. Section 024119 - Selective Structure Demolition: Removal of designated building equipment and construction.
3. Section 083113 - Access Doors and Frames: Execution requirements for access doors and panels specified by this section.

1.3 ACTION SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate demolition and removal sequence and location of salvageable items; location and construction of temporary work. Describe demolition removal procedures and schedule.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

- B. Project Record Documents: Record actual locations of capped utilities conduits and equipment abandoned in place, conduits and equipment remaining for future use and reconnection to new equipment.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Florida, City of Jacksonville, JEA, Federal and all other applicable codes and standards.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 013100 - Project Management and Coordination : Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 SEQUENCING

- A. Section 011000 - Summary: Requirements for sequencing.
- B. Sequence work in the following order:
 - 1. Coordinate with generator contractor and owner for providing temporary and construction power for period where site will be without utility power and permanent pump controls.
 - 2. Check in with general contractor and owner minimum 1 week before commencing with electrical demolition. Confirm bypass pumping systems and controls are in place before commencing demolition.
 - 3. Protect and mark all electrical systems wiring and conduit to remain mark in field with green tape and delineate on shop drawings.
 - 4. Remove equipment to be return to the Owner from the site inclusive of the generator (Wilson Blvd – Only).
 - 5. Demolish and replace electrical lighting systems with new. Provide temporary power for lighting systems until permanent power can be provided via the new Electrical building.
 - 6. Demolish all other electrical systems as indicated on the plans and approved shop drawings.

1.8 SCHEDULING

- A. Coordinate schedule with the general contractor and owner.
- B. Schedule work to coincide with new construction
- C. Perform noisy, malodorous, or dusty work:
 - 1. Between hours of 8 and 5 pm.
 - 2. On following days: Monday through Friday.

- D. Cease operations immediately when structure appears to be in danger and notify Engineer/Engineer. Do not resume operations until directed.

1.9 COORDINATION

- A. Conduct demolition to minimize interference with adjacent and occupied building areas.
- B. Coordinate demolition work with the general contractor and all other sub-contractors.
- C. Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition.
- D. Shut-down Periods:
 - 1. Arrange timing of shut-down periods of in service panels with general contractor. Do not shut down any utility without prior written approval.
 - 2. Keep shut-down period to minimum or use intermittent period as directed by general contractor and/or owner.
- E. Identify salvage items in cooperation with Owner and/or general contractor.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017300 - Execution : Verification of existing conditions before starting work.
- B. Verify wiring and equipment indicated to be demolished serve only abandoned facilities.
- C. Verify termination points for demolished services.

3.2 PREPARATION

- A. Erect, and maintain temporary safeguards, including warning signs and lights, barricades, and similar measures, for protection of the public, Owner, Contractor's employees, and existing improvements to remain.
- B. Temporary egress signage and emergency lighting

3.3 REMOVAL AND DISPOSAL OF LEGALLY REGULATED MATERIALS

- A. Material and equipment indicated to be removed and disposed of will become the Contractor's property. Dispose of material and equipment offsite, unless otherwise directed by the Owner.

Provide the Owner with a receipt indicating the acceptable disposal of any legally regulated materials or equipment.

- B. Assume that the ballasts in each existing lighting fixture contain PCB's, unless specifically marked with a label indicating "No PCBs." Remove ballasts from each lighting fixture and pack them in accordance with EPA PCB regulations. Ship ballasts in approved containers to an EPA approved recycling facility; pay all shipping, packaging and recycling costs.
- C. Remove, package, ship and dispose of PCBs, mercury and PCB/mercury contaminated equipment, in accordance with all State and Federal regulations. Retain the services of a firm licensed and regularly engaged in the removal of PCBs and PCB contaminated equipment. Retain a firm licensed in the State or States in which the contaminated material is handled, shipped and disposed of. Pay all fees associated with the removal of the contaminated material and equipment. Submit documentation indicating acceptable disposal.
- D. If PCB's or mercury contaminated equipment are discovered that were not identified; cease work on or about the equipment and notify the Engineer immediately.
- E. Remove the following electrical equipment to a location on the site for storage as directed by the Owner:
 - 1. Diesel Generator (Wilson Blvd – Only)

3.4 DEMOLITION

- A. Demolition Drawings are based on casual field observation and existing record documents. Report discrepancies to Engineer before disturbing existing installation.
- B. Remove exposed abandoned conduit, including abandoned [conduit] <_____> above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- C. Remove conduit, wire, boxes, and fastening devices to avoid any interference with new installation.
- D. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- E. Reconnect equipment being disturbed by renovation work and required for continue service to nearest available panel.
- F. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, and related switches, outlets, conduit and wiring which are not part of final project.
- G. Install temporary wiring and connections to maintain existing systems in service during construction.
- H. Perform work on energized equipment or circuits with experienced and trained personnel.
- I. Remove, relocate, and extend existing installations to accommodate new construction.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.

- K. Remove exposed abandoned grounding and bonding components, fasteners and supports, and electrical identification components, including abandoned components above accessible ceiling finishes. Cut embedded support elements flush with walls and floors.
- L. Clean and repair existing equipment to remain or to be reinstalled.
- M. Protect and retain power to existing active equipment remaining.
- N. Cap abandoned empty conduit at both ends.

3.5 EXISTING PANELBOARDS

- A. Ring out circuits in existing panel affected by the Work. Where additional circuits are needed, reuse circuits available for reuse. Install new breakers.
- B. Tag unused circuits as spare.
- C. Where existing circuits are indicated to be reused, use sensing measuring devices to verify circuits feeding Project area or are not in use.
- D. Remove existing wire no longer in use from panel to equipment.
- E. Provide new updated directories where more than three circuits have been modified or rewired.

3.6 SALVAGE ITEMS

- A. Remove and protect items indicated on Drawings to be salvaged and turn over to Owner.
- B. Items of salvageable value may be removed as work progresses. Transport salvaged items from site as they are removed.

3.7 REUSABLE ELECTRICAL EQUIPMENT

- A. Carefully remove equipment, materials, or fixtures which are to be reused.
- B. Disconnect, remove, or relocate existing electrical material and equipment interfering with new installation.
- C. Relocate existing lighting fixtures as indicated on Drawings. Clean fixtures and re-lamp. Test fixture to see if it is in good working condition before installation at new location.

3.8 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Remove demolished materials as work progresses. Legally dispose.
- C. Keep workplace neat.

3.9 PROTECTION OF FINISHED WORK

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not permit traffic over unprotected floor surface.

END OF SECTION 260505

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. 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. Mineral-insulated cable, Type MI, rated 600 V or less.
7. Tray cable, Type TC, rated 600 V or less.
8. Fire-alarm wire and cable.
9. Connectors, splices, and terminations rated 600 V and less.

- B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller, Variable Frequency Drive, or Adjustable speed drive.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.

- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden Inc.
 - 2. General Cable Technologies Corporation.
 - 3. Okonite Company (The).
 - 4. Service Wire Co.
 - 5. Southwire Company.
- 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.
- E. Conductor Insulation:
 - 1. Type RHW-2: Comply with UL 44.
 - 2. Type USE-2: Comply with UL 854.
 - 3. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 - 4. Type XHHW-2: Comply with UL 44.
- F. Shield:
 - 1. Type TC-ER: Cable designed for use with VFCs (adjustable speed drives), with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden Inc.
 - 2. Encore Wire Corporation.
 - 3. General Cable Technologies Corporation.
 - 4. Service Wire Co.
 - 5. Southwire Company.
- C. 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."
- D. Circuits:
 - 1. Single circuit and multicircuit with color-coded conductors.
- E. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- F. Ground Conductor: Insulated.
- G. Conductor Insulation:
 - 1. Type XHHW-2: Comply with UL 44.
- H. Armor: Aluminum, interlocked.
- I. Jacket: PVC applied over armor.

2.3 TRAY CABLE, TYPE TC

- A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Belden Inc.
 - 2. Encore Wire Corporation.
 - 3. General Cable Technologies Corporation.

4. [Okonite Company \(The\).](#)
5. [Service Wire Co.](#)
6. [Southwire Company.](#)

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. Comply with UL 1277.
4. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
5. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
6. 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.

E. Ground Conductor: Insulated.

F. Conductor Insulation: Type XHHW-2. Comply with UL 44.

G. Shield: Metallic.

2.4 CONNECTORS AND SPLICES

A. 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.

B. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:

1. [3M Electrical Products.](#)
2. [Burndy.](#)
3. [Hubbell Incorporated \(Hubbell Power Systems\).](#)
4. [ILSCO.](#)
5. [TE Connectivity Ltd.](#)

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: One or Two hole with long barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Feeders: Copper for feeders smaller than No. 4 AWG; copper 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.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway or Type USE, single conductor in raceway.
- B. Exposed Feeders: Type XHHW-2, single conductors in raceway Metal-clad cable, Type MC Type TC-ER cable in raceways.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Metal-clad cable, Type MC XHHW-2 single conductors in raceway .
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Feeders in Cable Tray: Type XHHW-2, single conductors larger than No. 1/0 AWG Metal-clad cable, Type MC or Type TC-ER cable.
- F. Exposed Branch Circuits, Including in Crawlspace: Type XHHW-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW-2, single conductors in raceway Metal-clad cable, Type MC.
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- I. Branch Circuits Installed below Raised Flooring: Type XHHW-2, single conductors in raceway.
- J. Branch Circuits in Cable Tray: Type XHHW-2, single conductors larger than No. 1/0 AWG Metal-clad cable, Type MC.
- K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

- L. VFC Output Circuits: Type XHHW-2 in metal conduit, Type TC-ER cable with dual tape shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least **6 inches (150 mm)** of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
 - 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. 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.

4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Backboards.
 - 2. Category 6 balanced twisted pair cable.
 - 3. Category 6a balanced twisted pair cable.
 - 4. Balanced twisted pair cabling hardware.
 - 5. RS-485 cabling.
 - 6. Low-voltage control cabling.
 - 7. Control-circuit conductors.
 - 8. Identification products.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: Provide samples of proposed wire in 12 inch size, type of insulation and voltage stenciled on the jacket.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

2.2 BACKBOARDS

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."
- B. Painting: Paint plywood on all sides and edges with flat white paint. Comply with requirements in Section 099123 "Interior Painting."
 - 1. Lead Content: Less than 300 parts per million.

2.3 CATEGORY 6 BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AMP NETCONNECT; a TE Connectivity Ltd. company.
 - 2. Belden CDT Networking Division/NORDX.
 - 3. General Cable; General Cable Corporation.
 - 4. Genesis Cable Products; Honeywell International, Inc.
 - 5. Mohawk; a division of Belden Networking, Inc.
 - 6. Prysmian Group North America.
 - 7. Superior Essex Inc.
- C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP) Screened and shielded twisted pairs (F/FTP).
- F. Cable Rating: Plenum.
- G. Jacket: Gray, Blue, or Yellow thermoplastic.

2.4 CATEGORY 6a BALANCED TWISTED PAIR CABLE (Profinet Cable)

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AMP NETCONNECT; a TE Connectivity Ltd. company.
 - 2. Belden CDT Networking Division/NORDX.
 - 3. Berk-Tek Leviton; a Nexans/Leviton alliance.
 - 4. General Cable; General Cable Corporation.
 - 5. Genesis Cable Products; Honeywell International, Inc.
 - 6. Mohawk; a division of Belden Networking, Inc.
 - 7. Prysmian Group North America.
 - 8. Superior Essex Inc.
 - 9. Siemens
- C. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- D. Conductors: 100-ohm, 23 AWG solid copper.
- E. Shielding/Screening: Shielded twisted pairs (FTP) Screened and shielded twisted pairs (F/FTP).

- F. Cable Rating: Plenum.
- G. Jacket: Gray, Blue, or Yellow thermoplastic.

2.5 BALANCED TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. 3M.
 - 2. American Technology Systems Industries, Inc.
 - 3. AMP NETCONNECT; a TE Connectivity Ltd. company.
 - 4. Belden CDT Networking Division/NORDX.
 - 5. CommScope, Inc.
 - 6. General Cable; General Cable Corporation.
 - 7. Genesis Cable Products; Honeywell International, Inc.
 - 8. Hubbell Incorporated (Hubbell Premise Wiring).
 - 9. Leviton Manufacturing Co., Inc.
 - 10. Mohawk; a division of Belden Networking, Inc.
 - 11. Panduit Corp.
 - 12. Prysmian Group North America.
 - 13. Superior Essex Inc.
- C. General Requirements for Balanced Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 5e Category 6 and Category 6a where applicable.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- D. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.
- E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

- F. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.
- G. Plugs and Plug Assemblies:
 - 1. Male; eight-position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
 - 2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
 - 3. Marked to indicate transmission performance.
- H. Jacks and Jack Assemblies:
 - 1. Female; eight-position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
 - 2. Designed to snap-in to a patch panel or faceplate.
 - 3. Standards:
 - a. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
 - b. Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.
 - c. Category 6a, unshielded balanced twisted pair cable shall comply with IEC 60603-7-41.
 - d. Category 6a, shielded balanced twisted pair cable shall comply with IEC 60603-7.51.
 - 4. Marked to indicate transmission performance.
- I. Legend:
 - 1. Machine printed, in the field, using adhesive-tape label.
 - 2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 RS-232 CABLE

- A. PVC-Jacketed, TIA 232-F:
 - 1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Polypropylene insulation.
 - 3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. NFPA 70 Type: Type CM.

7. Flame Resistance: Comply with UL 1581.

B. Plenum-Type, TIA 232-F:

1. Three, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PE insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. Fluorinated ethylene propylene jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.7 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.
6. Lead Content: Less than 300 parts per million.
- 7.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.8 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One or Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One or Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.

5. Flame Resistance: Comply with NFPA 262.

2.9 CONTROL-CIRCUIT CONDUCTORS

- 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. Encore Wire Corporation.
 2. General Cable; General Cable Corporation.
 3. Service Wire Co.
 4. Southwire Company.
- B. Class 1 Control Circuits: Stranded copper, Type XHHW-2, complying with UL 44 in raceway Type TC, complying with UL 1277 in raceway Type MC, complying with UL 1569.
- C. Class 2 Control Circuits: Stranded copper, Type XHHW-2, complying with UL 44 in raceway.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type XHHW-2, complying with UL 44 in raceway.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test cables on receipt at Project site.
 1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 1. Outlet boxes for cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
 2. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.

2. Install cable trays to route cables if conduits cannot be located in these positions.
 3. Secure conduits to backboard if entering the room from overhead.
 4. Extend conduits 4 inches. Insert dimension above finished floor.
 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- E. Backboards: Install backboards with **96-inch** dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding **30 inches** and not more than **6 inches** from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.

3. Do not untwist balanced twisted pair cables more than **1/2 inch** at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of **8 inches** above ceilings by cable supports not more than **30 inches** apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **5 inches**.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **12 inches**.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **24 inches**.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of **2-1/2 inches**.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **6 inches**.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **12 inches**.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of **3 inches**.

- c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of **6 inches**.
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of **48 inches**.
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches**.

3.4 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
 - 1. Class 1 remote-control and signal circuits; No 14 AWG.
 - 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
 - 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- H. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.
 - 2. Ground bonding common with lightning protection system.
 - 3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Ground rods.
 - 3. Ground rings.
 - 4. Grounding arrangements and connections for separately derived systems.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

- a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:
 - 1) Test wells.
 - 2) Ground rods.
 - 3) Ground rings.
 - 4) Grounding arrangements and connections for separately derived systems.
- b. Instructions for periodic testing and inspection of grounding features at test wells ground rings grounding connections for separately derived systems based on NETA MTS.
 - 1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - 2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB (Electrification Products Division).
 - 2. Advanced Lightning Technology, Ltd.
 - 3. Harger Lightning & Grounding.
 - 4. Hubbell Incorporated (Burndy).
 - 5. nVent (ERICO).

2.3 CONDUCTORS

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

1. Tinned Conductors: ASTM B33.
 2. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 5. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.
- CONNECTORS
- D. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- F. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- G. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- H. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- I. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- J. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- K. Conduit Hubs: Mechanical type, terminal with threaded hub.
- L. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt or socket set screw.
- M. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- N. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- O. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- P. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- Q. Straps: Solid copper, copper lugs. Rated for 600 A.
- R. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.
- S. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- T. Water Pipe Clamps:

1. Mechanical type, two pieces with stainless-steel bolts.
 - a. Material: Tin-plated aluminum.
 - b. Listed for direct burial.
2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.
- B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

2.5 EXOTHERMIC WELDING

- A. Exothermic welding shall be by CADWELD process, or equal. Molds and powder shall be furnished by the same manufacturer and sized and selected per manufacturer's instructions for specific combination of conductors and connected items.
- B. Welds used indoors in occupied buildings or confined spaces shall be the low emission type, CADWELD EXOLON or equal.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
 1. Bury at least 30inches below grade.
 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Separately derived systems such as transformers or generators (if identified as such) shall bond neutral and ground together with a bonding jumper at the equipment in accordance with NEC 250.102. Connection to the grounding electrode system via the electrode grounding conductor shall be in accordance with NEC Table 250.66 or as shown on the Drawings.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.
- D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-

copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
 - 9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.
- C. 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.
- D. 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.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. 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.
- F. 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."Poles Supporting Outdoor Lighting Fixtures" Paragraph below may supplement equipment grounding conductor and may be in excess of NFPA 70 requirements. Retain if necessary and coordinate with Drawings.
- G. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.
- H. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.6 FENCE GROUNDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
 - a. Gates and Other Fence Openings: Ground fence on each side of opening.
 - 1) Bond metal gates to gate posts.
 - 2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.7 INSTALLATION

- A. Grounding Electrode 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.
1. Where conductors pass through floor slabs, walls, etc., they shall be installed in conduit or sleeved.
 2. Conductors subject to mechanical damage shall be protected by non-ferrous conduit to avoid a choke effect for fault currents.
- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode

conductor, and install in conduit. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 2. Use exothermic welds for all below-grade connections.
 3. Rods shall be installed vertically and not allowed to be deformed or driven at an angle. Where driving is difficult or where rock is encountered, Contractor shall use purpose-designed drilling equipment, install the rod into the drilled hole and backfill around rod using ground enhancement material (GEM) mixed with water to form a slurry in accordance with the Manufacturer's instructions.
- C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.
1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

- G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart or as shown on the Contract Drawings.
- H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each **[indicated item]**, extending around the perimeter of building.
 - 1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
 - 2. Bury ground ring not less than 24 inches from building's foundation.
 - 3. Lay all underground conductors slack, and where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard.
- I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4/0 AWG.
 - 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 - 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- F. Grounding system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
 5. Substations and Pad-Mounted Equipment: 5 ohms.
 6. Manhole Grounds: 10 ohms.
- I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

- B. Related Requirements:

1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

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

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
 - 1. Hangers. Include product data for components.
 - 2. Slotted support systems.
 - 3. Equipment supports.
 - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
 - 1. Include design calculations and details of hangers.
 - 2. Include design calculations for seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Ductwork, piping, fittings, and supports.
 - 3. Structural members to which hangers and supports will be attached.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Bridge Cranes and/or Hoists
 - d. Access panels.
 - e. Projectors.
- B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2/D1.2M.

- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M.
 - 2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.
- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.5.
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Aluminum channel or Fiberglass channel with stainless steel hardware shall be used in areas designated "WET" or "CORROSIVE" on the Drawings and in outdoor locations. Fiberglass channel shall be resistant to the chemicals present in the area in which it is used.
- B. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be aluminum except that stainless steel shall be used in areas designated as "WET" or "CORROSIVE" on the Drawings.
- C. Conduit Supports:
 - 1. Trapezes:
 - a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be galvanized steel.
 - b. PVC coated steel beams, channels, struts or fiberglass beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels shall be resistant to the chemicals present in the area in which it is used.
 - 2. Flush Mounted Supports:

- a. In dry indoor areas, channels, struts, accessories and components shall be galvanized steel.
 - b. PVC coated steel channels, struts or fiberglass channels, struts with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels, struts shall be resistant to the chemicals present in the area in which it is used.
3. Conduit Racks:
 - a. In dry indoor areas, conduit racks, accessories and components shall be galvanized steel.
 - b. PVC coated steel conduit racks or fiberglass conduit racks with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels shall be resistant to the chemicals present in the area in which it is used.
4. Conduit Hangers:
 - a. In dry indoor areas, conduit clamps, rods, beam clamps, bracing, accessories and components shall be galvanized steel.
 - b. Stainless steel conduit clamps, rods, beam clamps, bracing, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.
- D. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB (Electrification Products Division).
 - b. Atkore International (Allied Tube & Conduit).
 - c. Atkore International (Unistrut).
 - d. Eaton (B-line).
 - e. nVent (CADDY).
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Stainless steel, Type 316 PVC Coated Steel.
 4. Channel Width: Selected for applicable load criteria.
 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- E. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum (10-mm-) diameter holes at a maximum of (200 mm) o.c. in at least one surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB (Electrification Products Division).
 - b. Atkore International (Unistrut).
 - c. Cooper Industries, Inc.
 - d. Flex-Strut Inc.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Material: 6063-T5 aluminum alloy.
 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 5. Channel Width: Selected for applicable load criteria.
 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- F. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Atkore International (Allied Tube & Conduit).
 - b. Eaton (B-line).
 - c. Seasafe, Inc.; AMICO, a Gibraltar Industries Company.
 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Channel Width: Selected for applicable load criteria.
 4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 6. Rated Strength: Selected to suit applicable load criteria.
 7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- G. Conduit and Cable Support Devices: Stainless-steel Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- H. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored 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 made of malleable iron.
- I. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

- J. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.
 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 where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Eaton (B-line).
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A F3125/F3125M, Grade A325 (Grade A325M).
 6. Toggle Bolts: Stainless-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA 101
 - 3. NECA 102.
 - 4. NECA 105.
 - 5. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with aluminum or stainless steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. 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, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69 or Spring-tension clamps.
 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 comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than (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, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099113 "Exterior Painting" Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

- B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
3. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.
- D. SSC: Stainless steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Sustainable Design Submittals:
 1. Product Data: For solvents and adhesives, indicating VOC content.

- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.
- D. Samples: For wireways nonmetallic wireways and surface raceways and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Data: Certificates, for enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Metal Conduit:
 - 1. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. ABB (Electrification Products Division).
 - b. Anamet Electrical, Inc (Anaconda Sealtite).
 - c. Atkore International (AFC Cable Systems).
 - d. Atkore International (Allied Tube & Conduit).
 - e. Atkore International (Calconduit).
 - f. Electri-Flex Company.
 - g. Emerson Electric Co. (Automation Solutions - Appleton - O-Z/Gedney).

- h. [FSR Inc.](#)
 - i. [Korkap.](#)
 - j. [NEC, Inc.](#)
 - k. [NewBasis.](#)
 - l. [Opti-Com Manufacturing Network, Inc \(OMNI\).](#)
 - m. [Patriot Aluminum Products, LLC.](#)
 - n. [Perma-Cote.](#)
 - o. [Plasti-Bond.](#)
 - p. [Republic Conduit.](#)
 - q. [Southwire Company.](#)
 - r. [Topaz Lighting & Electric.](#)
 - s. [Western Tube and Conduit Corporation.](#)
 - t. [Wheatland Tube Company.](#)
 - u. [Zekelman Industries \(Picoma\).](#)
- 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 3. ARC: Comply with ANSI C80.5 and UL 6A.
 - 4. IMC: Comply with ANSI C80.6 and UL 1242 (aluminum only).
 - 5. PVC-Coated Aluminum Conduit: PVC-coated rigid aluminum conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
 - 6. EMT: Comply with ANSI C80.3 and UL 797 (aluminum only).
 - 7. FMC: Comply with UL 1; aluminum.
 - 8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
 - 9. SSC: Comply with ASTM A312 and UL 6A. Type 316.

B. Metal Fittings:

- 1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB \(Electrification Products Division\).](#)
 - b. [Anamet Electrical, Inc \(Anaconda Sealtite\).](#)
 - c. [Atkore International \(AFC Cable Systems\).](#)
 - d. [Atkore International \(Allied Tube & Conduit\).](#)
 - e. [Atkore International \(Calconduit\).](#)
 - f. [Electri-Flex Company.](#)
 - g. [Emerson Electric Co. \(Automation Solutions - Appleton - O-Z/Gedney\).](#)
 - h. [FSR Inc.](#)
 - i. [Korkap.](#)
 - j. [NEC, Inc.](#)
 - k. [NewBasis.](#)
 - l. [Opti-Com Manufacturing Network, Inc \(OMNI\).](#)
 - m. [Patriot Aluminum Products, LLC.](#)
 - n. [Perma-Cote.](#)
 - o. [Plasti-Bond.](#)
 - p. [Republic Conduit.](#)

- q. [Southwire Company.](#)
 - r. [Topaz Lighting & Electric.](#)
 - s. [Western Tube and Conduit Corporation.](#)
 - t. [Wheatland Tube Company.](#)
 - u. [Zekelman Industries \(Picoma\).](#)
- 2. Comply with NEMA FB 1 and UL 514B.
 - 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
 - 5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
 - 6. Expansion Fittings: PVC or metal to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

- 1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [ABB \(Electrification Products Division\).](#)
 - b. [Anamet Electrical, Inc \(Anaconda Sealtite\).](#)
 - c. [Atkore International \(AFC Cable Systems\).](#)
 - d. [Hubbell Incorporated \(Raco Taymac Bell\).](#)
 - e. [Kraloy Fittings.](#)
 - f. [Lamson & Sessions.](#)
 - g. [United Fiberglass of America \(UFA\).](#)
- 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. Fiberglass:
 - a. Comply with NEMA TC 14.
 - b. Comply with UL 2515 for aboveground raceways.
 - c. Comply with UL 2420 for belowground raceways.
- 4. ENT: Comply with NEMA TC 13 and UL 1653.
- 5. RNC: Type EPC-40-PVC Type EPC-80-PVC (in roadways) , complying with NEMA TC 2 and UL 651 unless otherwise indicated.

6. LFNC: Comply with UL 1660.
7. Rigid HDPE: Comply with UL 651A.
8. Continuous HDPE: Comply with UL 651A.
9. Coilable HDPE: Preassembled with conductors or cables and complying with ASTM D 3485.
10. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. ABB (Electrification Products Division).
 - b. Anamet Electrical, Inc (Anaconda Sealtite).
 - c. Atkore International (AFC Cable Systems).
 - d. Cantex Inc.
 - e. Hubbell Incorporated (Raco Taymac Bell).
 - f. Kraloy Fittings.
 - g. Lamson & Sessions.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
 - a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.
5. Verify adhesive complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Conduit Supports: Provide the following types of conduit supports.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Add in requirements from legacy spec as required:
- B. For NEMA 1 wireways: gasketed painted steel with hinged cover. (This is NEMA 1 with an upgrade of a gasket, but not equivalent to NEMA 12). Hardware stainless steel. (Equivalent to Square Duct by Schneider Electric / Square D.)
- C. For NEMA 4X wireways: Type 316 stainless steel with gasketed hinged and clamped cover with drip lip. Hardware stainless steel. (Equivalent to Bulletin F 22 by Hoffman Engineering).
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB (Electrification Products Division).

2. [Eaton \(B-line\).](#)
3. [Hubbell Incorporated \(Wiegmann\).](#)
4. [MonoSystems, Inc.](#)
5. [nVent \(Hoffman\).](#)
6. [Schneider Electric USA \(Square D\).](#)

- E. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- G. Wireway Covers: Flanged-and-gasketed type unless otherwise indicated.
- H. Finish: Manufacturer's standard enamel finish.

2.4 MISCELLANEOUS FITTINGS

A. Flexible Couplings:

1. Manufacturers: Provide products by one of the following:
 - a. "Type ECGJH," by the Crouse-Hinds Co.
 - b. Appleton Electric Co.
 - c. Killark Electric Manufacturing Co.
 - d. Or equal.

B. Conduit Hubs:

1. Manufacturers: Provide products by one of the following:
 - a. Myers Electric Products, Inc.
 - b. Or equal.

C. Conduit Wall Seals for New Concrete Walls Below Grade:

1. Products: Provide one of the following:
 - a. O.Z./Gedney Co., Type WSK; [Linkseal].
 - b. Spring City Electrical Manufacturing Co., Type WDP.
 - c. Or equal.

D. Conduit Wall Seals for Cored Holes:

1. Products: Provide one of the following:
 - a. Type CSMC as manufactured by the O.Z./Gedney Co.

- b. Or equal.
- E. Conduit Wall and Floor Seals For Sleeved Openings:
 - 1. Products: Provide one of the following:
 - a. Type CSMI as manufactured by the O.Z./Gedney Co.
 - b. Or equal.
- F. Combination Expansion-Deflection Fittings Embedded in Concrete:
 - 1. Products: Provide one of the following:
 - a. Type XD as manufactured by the Crouse-Hinds Co.
 - b. Type DX as manufactured by O.Z./Gedney Co.
 - c. Type DF as manufactured by Appleton Electric Co.
 - d. Or equal.
- G. Combination Expansion-Deflection Fittings Installed Exposed:
 - 1. Products: Provide one of the following:
 - a. Type XD as manufactured by Crouse-Hinds Co.
 - b. Type DX as manufactured by O.Z. Gedney Co.
 - c. Type DF as manufactured by Appleton Electric Co.
 - d. Or equal.
- H. Explosion Proof Fittings:
 - 1. Manufacturers: Provide products by one of the following:
 - a. Crouse-Hinds Co.
 - b. Appleton Electric Co.
 - c. O.Z./Gedney Co.
 - d. Or equal.
- I. Conduit Sealing Bushings:
 - 1. Products: Provide one of the following:
 - a. O.Z./Gedney, Type CSB.
 - b. Or equal.
- J. Grounding Bushings: Malleable iron with integral insulated throat rated for 300 degrees F, with solderless lugs.
 - 1. Products: Provide one of the following:
 - a. Crouse Hinds/Cooper, Series HGLL.
 - b. Appleton, Series GIB.
 - c. O.Z./Gedney, Type HBLG.
 - d. Or equal.

2.5 BOXES, ENCLOSURES, AND CABINETS (NON-HAZARDOUS LOCATIONS)

- 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. ABB (Electrification Products Division).
 2. Adalet.
 3. Eaton (Crouse-Hinds).
 4. Emerson Electric Co. (Automation Solutions - Appleton - EGS).
 5. Emerson Electric Co. (Automation Solutions - Appleton - O-Z/Gedney).
 6. Hubbell Incorporated.
 7. Hubbell Incorporated (Wiring Device-Kellems).
 8. Legrand North America, LLC (Wiremold).
 9. nVent (Hoffman).
 10. Oldcastle Enclosure Solutions.
 11. Plasti-Bond.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Nonmetallic Floor Boxes: Nonadjustable, rectangular.
1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

- L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- M. Gangable boxes are allowed.
- N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4X with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Fiberglass.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

2.6 HAZARDOUS (CLASSIFIED) LOCATION BOXES

- A. Design explosion-proof boxes for Class 1, Group D, Division 1 hazardous locations. Provide cast iron with cadmium-zinc or hot-dipped galvanized finish, stainless steel or hot-dipped galvanized bolts;
 - 1. Manufacturer: Provide products by one of the following:
 - a. "Type EJB," by the Crouse-Hinds Company.
 - b. Appleton Electric Co.
 - c. The Pyle-National Co.
 - d. Or equal.
- B. Design explosion-proof boxes for Class 1, Group D, Division 1 hazardous locations, provided with O-ring seals to meet NEMA 4 requirements.
 - 1. Boxes and Covers: Aluminum, with stainless steel hinges and stainless steel bolts.
 - 2. Manufacturer: Provide products by one of the following:
 - a. "Type EJB-N4," by the Crouse-Hinds Co.
 - b. Appleton Electric Co.
 - c. Adalet-PLM
 - d. Or equal.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Armorcast Products Company.](#)
 - b. [Hubbell Incorporated \(Quazite\).](#)
 - c. [NewBasis.](#)
 - d. [Oldcastle Enclosure Solutions.](#)
 - e. [Oldcastle Precast, Inc.](#)
 2. Standard: Comply with SCTE 77.
 3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 6. Cover Legend: Molded lettering, "ELECTRIC."
 7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes **3 FEET BY 2 FEET** and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.
- C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. [Armorcast Products Company.](#)
 - b. [Hubbell Incorporated \(Quazite\).](#)
 - c. [NewBasis.](#)
 - d. [Nordic Fiberglass, Inc.](#)
 - e. [Oldcastle Enclosure Solutions.](#)
 - f. Oldcastle Enclosure Solutions.
 - g. [Oldcastle Precast, Inc.](#)
 2. Standard: Comply with SCTE 77.
 3. Color of Frame and Cover: Gray.
 4. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
 5. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 6. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 7. Cover Legend: Molded lettering, "ELECTRIC."
 8. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 9. Handholes 3 Feet by 3 Feet and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

TABLE 260533-1 Raceway Application Guidelines	
Raceway Type	Location / Application
Aluminum Rigid Conduit (ARC)	Used for all indoor and outdoor applications, except where other types are listed. All exposed, non-corrosive areas All concealed, non-corrosive areas Under slabs in slab on grade construction Flexible connections to transformers, motors, or other vibrating equipment: LFMC, maximum length 72-inches.
Electrical Metal Tubing (EMT)	Used for indoor air conditioned spaces in the Administration Building including the electrical room, mechanical room, control room, toilet areas, and office areas. Flexible connections to light fixtures shall be FMT
PVC Schedule 40	Concrete encased duct banks Embedded in concrete slabs or structures Elbows underground shall be ARC
PVC Schedule 80	Direct buried Corrosive areas Protection of grounding electrode conductors Protection of lightning conductors Flexible connections: LFNC

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- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: Aluminum Rigid Conduit (ARC).
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC Type EPC-80-PVC, concrete encased.
 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 4X – 316 Stainless Steel.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: ARC.
 2. Exposed, Not Subject to Severe Physical Damage: ARC.
 3. Exposed and Subject to Severe Physical Damage: ARC. Raceway locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- 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, boxes, or fittings in contact with concrete or earth.
- G. Install surface raceways only where indicated on Drawings.
- H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
 - 5. Change from ENT to PVC coated RAC before rising above floor.
- M. Stub-Ups to Above Recessed Ceilings:
 - 1. Use RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. 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.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- V. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Conduit extending from interior to exterior of building.
 - 4. Conduit extending into pressurized duct and equipment.
 - 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - 6. Where otherwise required by NFPA 70.
- Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, 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.
- BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- EE. Locate boxes so that cover or plate will not span different building finishes.
- FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- HH. Set metal floor boxes level and flush with finished floor surface.
- II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

- JJ. A maximum continuous run of conduit shall not exceed 300 feet and shall be reduced by 75 feet for each 90-degree elbow.
- KK. Provide a 4-inch concrete housekeeping pad at all slab and grade penetrations. Provide a 45 degree, 3/4-inch chamfer at all exposed edges.
- LL. Protect metallic finish conduit installed in contact with concrete or below grade with two coats of bitumastic paint, heat shrink tubing, or approved equivalent.
- MM. In hazardous locations, seal conduits terminating at boxes enclosing circuit opening equipment at the entrance to the enclosure with approved compound filled sealing fittings to prevent passage of explosive or combustible gases through the conduits. Similarly seal all conduits leading from or entering hazardous locations at points of exit or entrance. Seal exposed conduits passing through hazardous locations at both the entrance to and the exit from the hazardous locations. A sealing compound installation schedule shall be presented to the Engineer for approval. Sign off on each installation and present the compound installation schedule to the Engineer for final sign-off. Each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.
- NN. Install conduit sealing and drain fittings in all hazardous (classified) areas designated Class 1, Division 1, and Class 1, Division 2.
- OO. Install conduit sealing and drain fittings on all conduits entering and leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are the wet well and classified spaces. A sealing compound installation schedule shall be presented to Engineer for approval. Sign off on each installation and present the compound installation schedule to the Engineer for final sign-off. Each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.
- PP. Use liquid-tight flexible metal conduit for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal. The length of liquid-tight flexible metal conduit shall not exceed 36 inches when used for vibration isolation and shall not exceed 72 inches in length when attaching to luminaires. Non-metallic flexible conduit shall only be allowed for use with rigid PVC conduit systems.
- QQ. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earthwork" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earthwork."
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 of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earthwork."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
 6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
 7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 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 sieve to No. 4 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 above finished grade.
- D. Install handholes with bottom below frost line, a minimum of 24" below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for 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.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260536 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Ladder cable tray.
2. Wire-mesh cable tray.
3. Fiberglass cable tray.
4. Fiberglass channel cable tray.
5. Cable tray accessories.
6. Warning signs.

- B. Related Requirements:

1. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories serving communications systems.

1.3 ACTION SUBMITTALS

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

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

- B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to sides of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

- C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer who is licensed in the state where Project is located and who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
 2. Vertical and horizontal offsets and transitions.
 3. Clearances for access above and to side of cable trays.
 4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.
- B. Seismic Qualification Certificates: For cable trays, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAY

- A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
 1. Source Limitations: Obtain cable trays and components from single manufacturer.

- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles on individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE TRAY

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB (Electrification Products Division).
 - 2. Atkore International (Cope).
 - 3. Eaton (B-line).
 - 4. MP Husky USA Cable Tray & Cable Bus.
- B. Description:
 - 1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
 - 2. Width: 30 inches unless otherwise indicated on Drawings.
 - 3. Minimum Usable Load Depth: 6 inches.
 - 4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
 - 5. Rung Spacing: 9 inches o.c.
 - 6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
 - 7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
 - 8. No portion of the rungs shall protrude below the bottom plane of side rails.
 - 9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
 - 10. Fitting Minimum Radius: 12 inches.
 - 11. **Class Designation: Comply with NEMA VE 1, [Class 20C].**
 - 12. Splicing Assemblies: Bolted type using serrated flange locknuts.
 - 13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
- C. Materials and Finishes:
 - 1. Aluminum:
 - a. Materials: Alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.

- b. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.
- c. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2. Stainless Steel:

- a. Materials: Low-carbon, passivated stainless steel, Type 316L, ASTM F 593 and ASTM F 594.
- b. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.4 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 WARNING SIGNS

- A. Lettering: 1-1/2-inch- high, black letters on yellow background, with legend "WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL."
- B. Comply with Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1 and NEMA VE 1 where applicable.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable tray and support systems according to NEMA FG 1 and NEMA VE 2 where applicable.
- B. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
- C. Install cable tray, so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

- D. Remove burrs and sharp edges from cable trays.
- E. Join aluminum cable tray with splice plates; use four square-neck carriage bolts and locknuts.
- F. Fasten cable tray supports to building structure and install seismic restraints.
- G. Design fasteners and supports to carry cable tray, cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548.16 "Seismic Controls for Electrical Systems."
- H. Place supports, so that spans do not exceed maximum spans on schedules, and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of tray rungs.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Do not install more than one cable tray splice between supports.
- M. Make changes in direction and elevation using manufacturer's recommended fittings.
- N. Make cable tray connections using manufacturer's recommended fittings.
- O. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping." Install cable trays with enough workspace to permit access for installing cables.
- P. Install barriers to separate cables of different systems, such as power, communications, and data processing, or of different insulation levels, such as 600, 5000, and 15 000 V. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Cable trays with electrical power conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding-bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

- A. Install cables only when each cable tray run has been completed and inspected.
- B. Fasten cables on horizontal runs with cable clamps or cable ties. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.
- C. Fasten cables on vertical runs to cable trays every 18 inches.
- D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.
- E. Tie mineral-insulated cables down every 36 inches where required to provide a two-hour fire rating and every 72 inches elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

- A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.
- B. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
 - 2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
 - 3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items, such as pipes, hangers, or other equipment, in the cable tray.

5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 260536

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits and fittings, including RAC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High-density plastic boxes.
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 1. Two or more ducts installed in parallel, with or without additional casing materials.
 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

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

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for handholes, boxes, and other utility structures.
4. Include underground-line warning tape.
5. Include warning planks.

B. Shop Drawings:

1. Precast or Factory-Fabricated Underground Utility Structures:
 - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include reinforcement details.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
 - f. Include joint details.
2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- C. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- D. Source quality-control reports.
- E. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

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

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.8 FIELD CONDITIONS

- A. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. **RAC: Comply with ANSI C80.1 and UL 6.**

- B. Coated Steel Conduit: PVC-coated **RAC**.

- 1. Comply with NEMA RN 1.
- 2. Coating Thickness: 0.040 inch, minimum.

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

- 1. ABB (Electrification Products Division).
- 2. Atkore International (Allied Tube & Conduit).
- 3. Atkore International (Calconduit).
- 4. Korkap.
- 5. Perma-Cote.
- 6. Plasti-Bond.
- 7. Western Tube and Conduit Corporation.
- 8. Wheatland Tube Company.

- D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-80-PVC and Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Beck Manufacturing.
 2. Cantex Inc.
 3. Condux International, Inc.
 4. IPEX USA LLC.
 5. Lamson & Sessions.
 6. Manhattan/CDT.
 7. Spiraduct/AFC Cable Systems, Inc.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. Atkore International (Allied Tube & Conduit).
 - b. Cantex Inc.
 - c. Carlton; a brand of Thomas & Betts Corporation.
 - d. IPEX USA LLC.
 - e. Underground Devices, Inc.
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Christy Concrete Products.
 2. Oldcastle Precast, Inc.
 3. Utility Concrete Products, LLC.
 4. Utility Vault Co.
- C. Comply with ASTM C 858 for design and manufacturing processes.

- D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- E. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
- F. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
 - 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2. Cover Handle: Recessed.
- G. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
 - 1. Cover Hinges: Concealed, with hold-open ratchet assembly.
 - 2. Cover Handle: Recessed.
- H. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- I. Cover Legend: Molded lettering, as indicated for each service.
- J. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- K. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - 1. Extension shall provide increased depth of 12 inches.
 - 2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
- L. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- M. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - 1. Splayed location.
 - 2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - 3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - 4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - 5. Knockout panels shall be 1-1/2 to 2 inches thick.
- N. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
 2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
- O. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. **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. [Armorcast Products Company.](#)
 2. [Hubbell Incorporated \(Quazite\).](#)
 3. [Oldcastle Enclosure Solutions.](#)
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, as indicated for each service.
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

- A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

- B. **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. [Armorcast Products Company.](#)
 - 2. [Christy Concrete Products.](#)
 - 3. [Hubbell Incorporated \(Quazite\).](#)
 - 4. [Oldcastle Enclosure Solutions.](#)
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, as indicated for each service.
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 FIBERGLASS HANDHOLES AND BOXES

- A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of **[polymer concrete] [reinforced concrete] [cast iron] [hot-dip galvanized-steel diamond plate] [fiberglass]**.
- B. [Double click here to find, evaluate, and insert list of manufacturers and products.](#)>
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: **[Gray] [Green]**.
- E. Configuration: Units shall be designed for flush burial and have **[open] [closed] [integral closed]** bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, ["**ELECTRIC.**"] [as indicated for each service.] <Insert legend.>
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes [**12 inches wide by 24 inches long**] <Insert dimensions> and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.8 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Engineer.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Cables More Than 600 V: Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC Type EPC-40-PVC RNC, concrete-encased unless otherwise indicated.
- C. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC RNC, direct-buried unless otherwise indicated.
- D. Duct for Electrical Branch Circuits: Type EPC-80-PVC RNC, direct-buried unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths Walks and Driveways Roadways and Railroads: Type EPC-40 PVC RNC, encased in reinforced concrete.
- F. Stub-ups: Concrete-encased PVC-coated RAC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 - 5. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
 - 1. Duct shall have maximum of two 90-degree bends or the total of all bends shall be no more 180 degrees between pull points.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End Bell Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
 - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.

2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight-line duct with calculated expansion of more than 3/4 inch.
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- K. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.
- L. Concrete-Encased Ducts and Duct Bank:
 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earthwork" for pipes less than 6 inches in nominal diameter.
 2. Width: Excavate trench 12 inches wider than duct on each side.
 3. Width: Excavate trench 3 inches wider than duct on each side.
 4. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 7. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
 8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
 9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

- c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
- 10. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
- 11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
- 12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
- 13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
 - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
- 14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

- 1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earthwork" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
- 2. Width: Excavate trench 12 inches wider than duct on each side.
- 3. Width: Excavate trench 3 inches wider than duct on each side.
- 4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
- 5. Set elevation of bottom of duct bank below frost line.
- 6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
- 7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured PVC coated RAC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 - a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
 - b. Stub-ups to Outdoor Equipment: Extend concrete-encased RAC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
 - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earthwork" for installation of backfill materials.
 - a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
 - b. Place minimum 6 inches of engineered fill above concrete encasement of duct.
- N. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.
- O. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Install handholes with bottom below frost line.
2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
3. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Dampproofing: Apply dampproofing to exterior surfaces of and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Section 071113 "Bituminous Dampproofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

F. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box

extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi, 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
 - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

- B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Advance Products & Systems, Inc.
 - b. BWM Company.
 - c. CALPICO, Inc.
 - d. Flexicraft Industries.
 - e. Metraflex Company (The).
 - f. Pipeline Seal and Insulator, Inc.
 - g. Proco Products, Inc.
 - 2. Sealing Elements: EPDM or Nitrile (Buna N) rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 3. Pressure Plates: Stainless steel.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. HOLDRITE; Reliance Worldwide Company.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

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

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

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.

- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and Section 260573 "Power System Studies" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Identification, 600 V or Less: Use colors listed below for conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - 3. Colors for 240/120-V Circuits (Single Phase):
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Neutral: White.
 - 4. Colors for 240Δ/120-V Circuits (Three Phase, Four Wire, high leg, center tap):
 - a. Phase A: Black.
 - b. Phase B: Orange (high leg).
 - c. Phase C: Blue
 - d. Neutral: White.
 - 5. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.

- b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray.
- 6. Color for Equipment Grounds: Green.
- 7. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs 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."
- F. Equipment Identification and Source Nameplates:
 - 1. Black letters on a white field.
 - 2. Nameplates shall be engraved, laminated plastic, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch with 3/16-inch high lettering.
 - 3. All electrical equipment furnished under Divisions 26, 27, 28 and all equipment control panels furnished under other Divisions shall include equipment identification nameplates. Equipment includes switchgear, switchboards, motor control centers, panelboards, transformers, disconnect switches, separately mounted motor controllers, transfer switches, control panels, named terminal cabinets, etc. The designation of the equipment shall correspond to the designation shown on the Drawings.
 - 4. Equipment identified in the previous paragraph above shall also include a nameplate with the power source identified
- G. Device Identification Labels:
 - 1. Black letters on a white field.
 - 2. Labels shall be self-adhesive type and machine generated with 1/4-inch high letters.
 - 3. All receptacles, wall switches, lighting fixtures, photo cells, emergency lights, exit lights, instruments, etc. shall be identified with the panel and circuit to which it is connected.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. **Manufacturers:** Subject to compliance with requirements, **[provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:**
 - a. Graphic Product's.
 - b. [Brady Corporation.](#)
 - c. [Champion America.](#)
 - d. [Panduit Corp.](#)
 - e. [Seton Identification Products; a Brady Corporation company.](#)
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
 1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Graphic Product's.
 - b. [Brady Corporation.](#)
 - c. [HellermannTyton.](#)
 - d. [Marking Services, Inc.](#)
 - e. [Panduit Corp.](#)
 - f. [Seton Identification Products; a Brady Corporation company.](#)
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following:
 - a. Graphic Product's.
 - b. [A'n D Cable Products.](#)
 - c. [Brady Corporation.](#)
 - d. [Brother International Corporation.](#)
 - e. [Panduit Corp.](#)
 - f. [Seton Identification Products; a Brady Corporation company.](#)
 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
 4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:

- a. [Brady Corporation.](#)
- b. [Brother International Corporation.](#)
- c. [Marking Services, Inc.](#)
- d. [Panduit Corp.](#)
- e. [Seton Identification Products; a Brady Corporation company.](#)

2. Minimum Nominal Size:

- a. 1-1/2 by 6 inches for raceway and conductors
- b. 3-1/2 by 5 inches for equipment.
- c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by the following:

- a. [Brady Corporation.](#)
- b. [HellermannTyton.](#)
- c. [Marking Services, Inc.](#)
- d. [Panduit Corp.](#)

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by the following:

- a. [Brady Corporation.](#)
- b. [Panduit Corp.](#)

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by the following:

- a. [Carlton Industries, LP.](#)
- b. [Ideal Industries, Inc.](#)
- c. [Marking Services, Inc.](#)
- d. [Panduit Corp.](#)

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.
- C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.
 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Brimar Industries, Inc.
 - b. HellermannTyton.
 - c. Marking Services, Inc.
 - d. Seton Identification Products; a Brady Corporation company.
- D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlton Industries, LP.
 - b. Seton Identification Products; a Brady Corporation company.
- E. Underground-Line Warning Tape:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Marking Services, Inc.
 - d. Seton Identification Products; a Brady Corporation company.
 2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines by either conductive or inductive location techniques.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 3. Color and Printing:

- a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" Insert inscription.
 - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE" .
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

- A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. Grafoplast Wire Markers.
 - d. Panduit Corp.
 - e. Seton Identification Products; a Brady Corporation company.

2.7 SIGNS

- A. Baked-Enamel Signs:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Carlton Industries, LP.
 - b. Champion America.
 - c. emedco.
 - d. Marking Services, Inc.
 2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
 3. 1/4-inch grommets in corners for mounting.
 4. Nominal Size: 7 by 10 inches.
- B. Metal-Backed Butyrate Signs:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Brady Corporation.](#)
 - b. [Champion America.](#)
 - c. [emedco.](#)
 - d. [Marking Services, Inc.](#)
2. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
 3. 1/4-inch grommets in corners for mounting.
 4. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Brady Corporation.](#)
 - b. [Carlton Industries, LP.](#)
 - c. [emedco.](#)
 - d. [Marking Services, Inc.](#)
2. Engraved legend.
3. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

- 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. [HellermannTyton.](#)
 2. [Ideal Industries, Inc.](#)
 3. [Marking Services, Inc.](#)
 4. [Panduit Corp.](#)
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.

- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.

- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY/STANDBY POWER."
 - 2. "POWER."
 - 3. "UPS."
- M. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

- Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- W. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
 - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- X. Metal Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using UV-stabilized cable ties.
- Y. Nonmetallic Preprinted Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using general-purpose UV-stabilized cable ties.
- Z. Baked-Enamel Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.
- AA. Metal-Backed Butyrate Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

BB. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high sign; where two lines of text are required, use labels 2 inches high.

CC. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

DD. Equipment Nameplates:

1. Nameplates shall be screw mounted to NEMA 1 enclosures.
2. Nameplates shall be bonded to all other enclosure types using an epoxy or similar waterproof adhesive.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- high, black letters on 20-inch centers.
 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.
- D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels or Snap-around labels.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels and vinyl tape applied in bands.
 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

- F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels or snap-around labels to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.
- I. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.
- J. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- K. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- L. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- M. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- N. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- O. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

- P. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. 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.
- Q. Arc Flash Warning Labeling: Self-adhesive labels.
- R. Operating Instruction Signs: Metal-backed, butyrate warning signs.
- S. Emergency Operating Instruction Signs: Metal-backed, butyrate warning signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer and emergency stop buttons.
- T. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 - 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - g. Substations.
 - h. Emergency system boxes and enclosures.
 - i. Motor-control centers.
 - j. Enclosed switches.
 - k. Enclosed circuit breakers.
 - l. Enclosed controllers.
 - m. Variable-speed controllers.
 - n. Push-button stations.
 - o. Power-transfer equipment.
 - p. Contactors.
 - q. Remote-controlled switches, dimmer modules, and control devices.
 - r. Battery-inverter units.
 - s. Battery racks.
 - t. Power-generating units.
 - u. Monitoring and control equipment.
 - v. UPS equipment.
 - w. .

U. Junction and Pull Box Nameplates:

1. All voltages (e.g. 480 volts, 120 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Provide Signs with red background with white engraved lettering. Provide lettering a minimum of 1 inch high.

V. Panelboard Identification

1. Label branch circuit wires with associated pole number using vinyl cloth wrap around labels.
2. Provide typed as built circuit directories giving location and nature of load served. Install circuit directories in each panelboard.
3. Provide each panelboard with two nameplates. The first shall be provided by the panelboard manufacturer and shall identify the panel. The second shall be field installed by the Contractor to identify the panel's upstream power source.

END OF SECTION 260553

SECTION 260573 - POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes a computer-based study for:
 - 1. Short circuit report.
 - 2. Protective device coordination report.
 - 3. Motor starting report.
 - 4. Arc flash report.
 - 5. Harmonic analysis report.
- B. Study encompasses the power distribution system of the Client and Facility. Facilities are as follows:
 - 1. 118th Street Pump Station (Entire Station)
 - 2. Wilson Boulevard Pump Station (Entire Station)
- C. Study includes the electric utility company's protective devices, emergency generators, service entrance equipment and distribution including all AC and DC equipment 24V and greater. All power distribution to that point whether existing or new is included. Equipment included, but not limited to:
 - 1. Substations and distribution.
 - 2. Switchgear, switchboards, and panelboards.
 - 3. Motor control centers.
 - 4. Variable frequency controllers.
 - 5. Disconnect switches.
 - 6. Transfer switches.
 - 7. 480V control panels.
 - 8. 480V power panels
 - 9. 120/208V power panels
 - 10. PLC/RTU Insert Additional Requirement – PLC control panels, etc. for arc flash labels only.
 - 11. **UPS panels**
- D. The local electric utility is JEA.
- E. Obtain all data necessary to perform the study. Data included, but not limited to:
 - 1. Up to date one-line diagrams.

2. Equipment data.
3. Cable sizes and lengths.
4. Existing protective device settings.
5. Electric utility information: available fault current, protective device equipment information and settings, X/R ratios, transformer impedances and ratings.

1.3 DEFINITIONS

- A. Boundary, Arc Flash: When an arc flash hazard exists, an approach limit from an arc source at which the incident energy equals 1.2 cal/cm^2 (5 J/cm^2).
- B. Boundary, Limited Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.
- C. Boundary, Restricted Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.
- E. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.
- F. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- G. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.
- H. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.
- I. Preliminary Short Circuit Report: Report that includes the maximum available utility fault current, proposed equipment, and existing equipment to determine if new equipment may be released for manufacturing and existing equipment is adequate for the calculated short circuit levels.
- J. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- K. SCCR: Short-circuit current rating.
- L. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- M. Single-Line Diagram: See "One-Line Diagram."

- N. Supplier: The person, firm or corporation identified as such to provide the power system study and means the Supplier or its authorized agent. See also Power Systems Analysis Specialist.

1.4 ACTION SUBMITTALS

- A. Supplier qualifications per Quality Assurance paragraph. Submit prior to starting study. Include the following:
 - 1. Brief description of each qualifying study.
 - 2. Name of owner of installation on which study was performed with address, telephone number, and contact person.
 - 3. Date of study.
 - 4. Any other information indicating the firm's experiences and ability to perform the work and business status.
- B. Preliminary Power System Study Report. Report must be approved prior to release for manufacture of major electrical equipment including but not limited to switchgear, switchboards, distribution panels, and motor control centers. Fault data from the utility must be included and not assumed or submittal will be rejected.
- C. Final Power System Study Report. Report must be approved prior to energization of new major electrical equipment. Revise study as required for changes during construction.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
 - 1. For Power Systems Analysis Software Developer.
 - 2. For Power System Analysis Specialist.
 - 3. For Field Adjusting Agency.
- B. If requested, Product Certificates: For power system study software, certifying compliance with IEEE 399, IEEE 1584 and NFPA 70E.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Final power system study updated with any changes made after equipment start-up.
- B. Digital computer files with full read-write access of the complete power system model and library.

1.7 QUALITY ASSURANCE

- A. Perform Study using commercially developed and distributed software designed specifically for power system analysis.

- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications:
 - 1. Design computer program to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
 - 2. Develop computer program under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
 - 3. Complies with IEEE 399, IEEE 141, IEEE 242, IEEE 519, IEEE 1015, and IEEE 1584 as applicable to the project scope.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located and has regularly engaged in this electrical engineering study specialty for minimum of five years and has performed at least three projects of similar complexity to this project within the last three years. Perform all elements of the study under the direct supervision and control of this professional engineer.
- F. Power System Study Certification: Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
 - 1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
 - 2. A member company of NETA.
 - 3. Acceptable to authorities having jurisdiction.

1.8 POWER SYSTEM STUDY MEETINGS

- A. Supplier's professional engineer responsible for the study to attend a meeting with the Engineer and Owner at the Owner's facility up to and including three times.
- B. Purpose of the three meetings are:
 - 1. Initial meeting discusses the study's scope and the Owner's operational and maintenance requirements prior to the preliminary study submittal.
 - 2. Second meeting discusses the preliminary study and its recommendations. Based on this meeting, the Owner may request modifications to the studies' recommended protective settings to reduce the arc flash hazard or meet other operational objectives.
 - 3. Third and final meeting presents the final study and its recommendations.
- C. Provide a minimum of three-week notice to the Owner and Engineer in advance of all projected meeting dates.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Acceptable Software:

1. SKM System Analysis, Inc.: Power*Tools
2. Operation Technology, Inc.: ETAP (Electrical Transient Analyzer Program)
3. EasyPower, Inc.: EasyPower
4. Or equal.

2.2 POWER SYSTEM STUDY REPORT GENERAL REQUIREMENTS

- A. Except for one-line diagrams, standard 8 ½-in by 11-in pages, with total pages numbered.
- B. Electronic PDF format copy with electronic bookmarks for each section.
- C. Signed and sealed by a professional engineer registered in the state in which the project is located.
- D. Organized in the following order:
1. Executive Summary
 2. Short Circuit Analysis
 3. Short Circuit Computer Printout
 4. Protective Device Coordination
 5. Motor Starting
 6. Arc Flash Hazard Analysis
 7. Harmonic Analysis
 8. Utility Data
 9. Modeled One Line Diagrams
- E. Information on one-line diagrams, legible when printed at 11-in x 17-in. Show the following:
1. Protective device designations and ampere ratings.
 2. Conductor types, sizes, and lengths.
 3. Transformer kilovolt ampere (kVA), impedance, and voltage ratings.
 4. Motor and generator designations and kVA ratings.
 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 6. Derating factors and environmental conditions.
 7. Any revisions to electrical equipment required by the study.
- F. Identifiers between the one-line diagram, short circuit study, coordination study, and arc flash study to be the same.
- G. Include copies of correspondence with electric utility under utility data section of report. Correspondence to include names and contact information.

2.3 EXECUTIVE SUMMARY

- A. Include summary of distribution system, information received from electric utility, major assumptions, adequacy of equipment to safely clear or close on any fault, identify problem areas and recommendations for resolving problem areas.

2.4 SHORT CIRCUIT

- A. Comply with IEEE 399 and IEEE 551 (new 3002 series).
- B. Include normal utility powered configuration, on-site generation configuration, and alternate modes of operation (i.e. alternate utility configuration, bus ties closed).
- C. Include minimum and maximum possible fault conditions. Address three-phase bolted as well as ground fault conditions.
- D. Consider the fault contribution of all motors operating during the maximum demand condition of the motors.
- E. Calculate short-circuit momentary duties and interrupting duties based on an assumed bolted three-phase short circuit at each high and medium voltage switchgear bus and controller, low voltage switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard and other significant locations throughout the systems. Include the X/R ratios, asymmetry factors, KVA and symmetrical fault-current in the short circuit tabulations. Provide a ground fault current study for the same system areas. Include in tabulations fault impedance, X/R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault-currents.
- F. Include representation of the site power system, the base quantities selected, impedance source data, calculation methods and tabulations, one-line diagrams, conclusions and recommendations.
- G. Identify available fault current at each bus and evaluate system elements including but not limited to equipment, protective devices, and cables.
- H. Base current transformers' ratio and burden calculations on a 10 percent maximum ratio error per IEEE C57.13. Identify current transformers that will not allow the protective devices to operate within acceptable IEEE error margins and recommend corrective action.
- I. List momentary, interrupting, and/or withstand rating of all key elements of the distribution system along with the maximum available fault current in tabular form and clearly indicate the adequacy of the element with PASS / FAIL designation.
- J. Short Circuit Computer Printout:
 - 1. Calculations shall be in sufficient detail for easy review.
 - 2. Back up calculations shall become part of the final report.

2.5 PROTECTIVE DEVICE COORDINATION

- A. Comply with IEEE 242 (new 3004 series).
- B. Utilize results from the short circuit study and balance the competing objectives of protection and continuity of service for the system specified, considering the basic factors of sensitivity, selectivity and speed.
- C. Show graphic indication of coordination between protective devices in the form of full color time-current coordination (TCC) plots with each protective device curve in a unique color for easy review.
- D. Provide separate TCC plots for each mode of operation. Provide separate TCC plots for “normal” and “stand by” operation. Show maximum fault values in each case. Both power sources shown on one plot is unacceptable.
- E. Provide separate TCC for phase over-current and ground fault.
- F. Show no more than six devices on one TCC. Of these six curves, two (the largest upstream device and the smallest downstream device) shall repeat curves shown on other coordination plots to provide cross-reference. Designate each TCC with a unique identifier and include each TCC identifier and descriptive title in the study’s table of contents.
- G. Include in each TCC the following as applicable:
 - 1. TCC name and description.
 - 2. One-line diagram.
 - 3. Identifiers on one-line diagram and curves.
 - 4. Significant motor starting characteristics.
 - 5. Appropriate NEC protection points.
 - 6. Appropriate ANSI/IEEE protection points.
 - 7. Magnetizing inrush points of transformers.
 - 8. Transformer damage curves.
 - 9. Complete operating bands for low voltage circuit breaker trip devices and fuses.
 - 10. Relay coil taps, time-dial settings and pickup settings.
 - 11. Significant symmetrical and asymmetrical fault currents.
 - 12. Power cable withstand curves.
 - 13. Generator short circuit decrement and thermal limit curves.
- H. Terminate device characteristic curve on TCC at a point reflecting the maximum symmetrical or asymmetrical fault current to which that device is exposed, based on the short circuit study.
- I. Select each primary protective device for a delta-to-wye-connected transformer so the characteristic or operating band is within the transformer parameters; where feasible, include a parameter equivalent to 58 percent of the ANSI C37.91 withstand curve to afford protection for secondary line-to-ground faults.
- J. Separate low voltage power circuit breakers from each other and the associated primary protective device, by a 16 percent current margin for coordination and protection in the event of line-to-line faults.

- K. Separate protective relays by a 0.3-second time margin for the maximum 3 phase fault conditions to assure proper selectivity.
- L. Optimize settings for breakers and relays to provide the most effective protection practicable for all modes and power sources.
- M. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center and/or power distribution panelboard. Include all adjustable setting ground fault protective devices.
- N. Provide tabulations of recommended settings for all protective devices. Where devices are existing, highlight any changes from the existing setting to the proposed recommended setting.
- O. Provide all information required to program/set multifunction solid state relays.

2.6 MOTOR STARTING

- A. Comply with IEEE 141 (new IEEE 3001 series) for recommended light flicker limits and IEEE 3002.7 for motor starting studies.
- B. Provide motor starting study for all large electric drives (100 horsepower and larger). Include all operating modes.
- C. Identify any concerns about voltage drop or power inrush limitations due to the starting of motors.

2.7 ARC FLASH HAZARD

- A. Comply with IEEE 1584, NFPA 70, and NFPA 70E as applicable.
- B. Utilize short circuit and protective device coordination results to provide arc flash hazard analysis. Perform calculations in accordance with IEEE 1584 or NFPA 70E with the method identified within the report.
- C. Calculate the incident energy levels at each faulted bus for each mode of operation and for both maximum and minimum fault currents.
- D. Include calculations at line side and load side of main breakers, where applicable.
- E. Provide tabular report for all modes and conditions and include “worst case” summary. Use the “worst case” to generate the arc flash labels. Include:
 - 1. Fault location
 - 2. Arcing fault magnitude
 - 3. Protective device clearing time
 - 4. Duration of the arc
 - 5. Arc flash boundary
 - 6. Working distance
 - 7. Incident energy
 - 8. Electrode configuration

- F. Highlight any available incident energy over 40 cal/cm² and provide recommendations to mitigate the hazard.
- G. Arc Flash Labels:
 - 1. Machine printed, 4-in x 4-in (nominal), thermal transfer, high adhesion polyester.
 - 2. Provide UV resistant laminate for outdoor labels.
- H. Arc Flash Label Information:
 - 1. Equipment name.
 - 2. Identifier LINE or LOAD where equipment has potential different energy levels.
 - 3. Arc flash hazard information: arc flash boundary and incident energy in cal/cm².
 - 4. Shock hazard information: limited approach and restricted approach boundaries.
 - 5. Personal Protective Equipment (PPE) requirements.
 - 6. Study Supplier, project number, and date.
- I. Provide arc flash label sample with preliminary report.
- J. Do not be print the labels until equipment is energized and protective devices set according to the approved final protective device coordination study.

2.8 HARMONIC ANALYSIS

- A. Comply with IEEE 519 and IEEE 3002.8.
- B. Provide a harmonic analysis for all major harmonic producing equipment to determine the harmonic currents and voltages of the electrical distribution system. Include utility and alternate power sources, if applicable. Major harmonic producing equipment includes: **Wastewater Pump VFDs, and UPS equipment.**
- C. Provide a harmonic current and voltage profile for the complete electrical distribution system. At a minimum, the voltage profile shall include voltage values at the utility service point, and at each switchgear/switchboard and motor control center bus.
- D. Provide calculations for all operating modes and the following conditions:
 - 1. One profile for all duty equipment running with variable frequency controllers at full speed.
 - 2. One profile for all duty equipment running with variable frequency controllers at 60% speed.
 - 3. One profile for one variable frequency controller at 60% and all duty equipment running
- E. Include in the analysis:
 - 1. Explanation of analysis method.
 - 2. Explanation of analysis and recommendations to meet the specified limits.
 - 3. Calculations and/or computer printouts.
 - 4. Harmonic current and voltage profiles up to the fiftieth harmonic.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain all data necessary for conduct of the study.
 - 1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Engineer's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 - 3. For relocated equipment and that which is existing to remain, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.
- B. Gather and tabulate the required input data to support the power system study.
- C. Field data gathering for existing systems shall be under direct supervision and control of the engineer in charge of performing the study and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
- D. Data included, but are not limited to, the following:
 - 1. Product data for overcurrent protective devices and existing settings.
 - 2. Electrical power utility impedance at the service and upstream protective device data.
 - 3. Power sources and ties.
 - 4. For switchgear, switchboards, panelboards, and motor control centers, ampacity and SCCR in amperes RMS symmetrical.
 - 5. For transformers, kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - 6. For reactors, manufacturer and model designation, voltage rating, and impedance.
 - 7. For circuit breakers, trip units, and fuses, manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 - 8. For generators, short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 - 9. For busways, manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 - 10. For motors, horsepower and NEMA MG 1 code letter designation.
 - 11. Conductor sizes, lengths, number, conductor material, shield parameters for medium voltage cable, and conduit material (magnetic or nonmagnetic).
 - 12. For relays, manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 - 13. Derating factors.

3.2 FIELD QUALITY CONTROL

- A. Do all testing and adjustment prior to the energization of new equipment.

- B. Test existing adjustable protective devices in accordance with NETA MTS.
- C. Test new adjustable protective devices in accordance with NETA ATS.
- D. Adjust existing and new protective devices according to approved coordination study.
- E. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.
- F. After successful testing and adjustment, install calibration sticker with Field Adjusting Agency name, employee initials, and date of calibration at each relay or protective device.
- G. After energization, minor adjustments to settings may be required to commission the equipment.
- H. Submit field report and list any changes made during field adjustment or commissioning for update for record submittal of study.

3.3 ARC FLASH LABELING

- A. After the field adjustment of relays and protective devices, apply arc flash study labels.
- B. Apply arc flash labels on the front covers of the following equipment:
 - 1. Substations and distribution transformers
 - 2. Medium voltage switches
 - 3. Switchgear, switchboards, and panelboards
 - 4. Motor control centers
 - 5. Variable frequency controllers
 - 6. Disconnect switches
 - 7. Transfer switches
 - 8. 480V control panels
 - 9. 480V Power Panels
 - 10. 120/208V Power Panels
 - 11. Panels with voltages greater than 24VAC/VDC
 - 12. PLC/RTU**
- C. Apply arc-flash labels at each section for large equipment such as switchgear and motor control centers.
- D. Install LINE and LOAD arc-flash labels as applicable.
- E. Remove any previous arc flash study labels as applicable and install new labels under the direction of the Power System Analysis Specialist.

END OF SECTION 260573

SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes equipment and systems used to monitor and control electrical consumption:
 - 1. Multifunction meters.
 - 2. Power meters.
 - 3. Circuit meters and monitors.
 - 4. Circuit meters and explorer instruments.
 - 5. Electrical power monitoring system software.
 - 6. Electrical power monitoring and control software.
 - 7. Network configuration software.
 - 8. Monitoring and control of power distribution equipment.
 - 9. System operator interfaces.
 - 10. Raceways and boxes.
 - 11. Wires and cables.
 - 12. Identification.
- B. Related Requirements:
 - 1. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

1.3 DEFINITIONS

- A. Active Power: The average power consumed by a unit. Also known as "real power."
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. Apparent (Phasor) Power: " $S = VI$ " where "S" is the apparent power, "V" is the rms value of the voltage, and "I" is the rms value of the current.
- D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

- F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.
- G. LAN: Local area network.
- H. L-G: Line to ground.
- I. L-L: Line to line.
- J. L-N: Line to neutral.
- K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- L. Modbus TCP/IP: An open protocol for exchange of process data.
- M. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- N. N-G: Neutral to ground.
- O. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.
- P. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- Q. TCP/IP: Transport control protocol/Internet.
- R. UPS: Uninterruptible power supply; used both in singular and plural context.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For power monitoring and control equipment.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.
 - a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:
 - 1) Location of the meters and gateways, and routing of the connecting wiring.

- 2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Network naming and numbering scheme.
5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
6. Specifications for workstations.
7. UPS sizing calculations for workstation.
8. Surge Suppressors: Data for each device used and where applied.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Design Data:
 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
 - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - g. Engineering, installation, and maintenance manuals that explain how to do the following:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
 - h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
 - i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.

- j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
- l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- m. Owner training materials.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power monitoring and control units to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Provide separately for each PC.
 - 5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on compact disk or portable storage device with a USB interface of the hard-copy submittal.
 - 6. Program Software Backup: On compact disk or portable storage device with a USB interface, complete with data files.
 - 7. Device address list.
 - 8. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
 - 2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.
 - 1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:
 - 1. Electrical meters that monitor, control, and connect to the data transmission network.
- B. The electrical power monitoring and control system shall be Internet based.
 - 1. System software shall be based on server thin-client architecture, designed around open standards of internet technology.
 - 2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
 - 3. Internet access shall be password protected.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. UL Compliance: Listed and labeled as complying with UL 61010-1.

2.2 PERFORMANCE REQUIREMENTS

- A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
 - 1. Minimum Protection for Power Lines 120 V and More: SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction. Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

- B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.
- C. Backup Power Source:
 - 1. Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS <Insert drawing designation>

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB.
 - 2. Eaton.
 - 3. Schneider Electric USA, Inc.
 - 4. Siemens.
- B. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.
 - 1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
 - 2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Indoor installation in non-air-conditioned nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of **minus 4 deg to 158 deg F** dry bulb and 5 to 95 percent relative humidity, noncondensing.
 - 2. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.
- D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
- E. Accuracy:
 - 1. Comply with ANSI C12.20, Class 0.5.
 - 2. Neutral Current Measurement: Not more than 0.65 percent.
 - 3. Power Factor: 1.0 percent.
 - 4. Frequency: 0.1 percent.
 - 5. THD: 1.0 percent.
 - 6. Waveform Sampling: 64 per cycle.
- F. Data Link:

1. RS-485 Modbus, RTU protocol, 2-wire connection to host devices with a compatible port.
2. Profinet, RTU protocol, 2 wire connection to host devices with a compatible port.

G. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values:
 - a. One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:
 - 1) All meters.
 - 2) Measurements.
 - 3) THD.
 - 4) Energy.
 - 5) Demand.
 - 6) Minimum and maximum values.
 - 7) Power demand.

H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.

I. Meters:

1. Instantaneous, rms:
 - a. Current: Each phase, neutral and three-phase average.
 - b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - c. Active Power (kW): Each phase and three-phase total.
 - d. Reactive Power (kVAR): Each phase and three-phase total.
 - e. Apparent Power (kVA): Each phase and three-phase total.
 - f. Power Factor: Each phase and three-phase total.
2. Energy:
 - a. Active Energy (kWh): Three-phase total.
3. Demand, Derived from Instantaneous rms Meters:
 - a. Current: Present and maximum.
 - b. Active: Present and maximum.
 - c. Reactive: Present and maximum.
 - d. Apparent: Present and maximum.
4. Power Quality Measurements:
 - a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

- J. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics shall be 150 mA at 200 V.
1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:
 - a. User-defined pulse output, associated with kWh.
 - b. User-defined pulse output, associated with kVARh.

2. **<Insert control function>.**

K. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:
 - a. Voltage: Measurement autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
 - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
 - c. Frequency: 45 to 65 Hz.
 - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 POWER METERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB.
 2. Eaton.
 3. Leviton Manufacturing Co., Inc.
 4. Schneider Electric USA, Inc.
 5. Siemens Industry, Inc., Energy Management Division.
- B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.
1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
 2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in non-air-conditioned nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of **minus 13 to 158 deg F** dry bulb and 20 to 90 percent relative humidity, noncondensing.
 2. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.
- D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
- E. Accuracy:
1. Comply with ANSI C12.20, Class 0.5.
 2. Neutral Current Measurement: Not more than 0.65 percent.
 3. Power: 0.6 percent.
 4. Power Factor: 0.5 percent.
 5. Active Energy: 0.6 percent.
 6. Reactive Energy: 2.5 percent.
 7. Frequency: 0.05 percent.
 8. THD: 1.0 percent.
 9. Waveform Sampling: 32 per cycle.
- F. Data Link:
1. Profinet protocol, 4 wire connection.
 - a. Provide for firmware and software updates through the communications port..
 - b. Use of a protocol converter/profinet gateway is acceptable where meter does not use profinet as native protocol. (This is not applicable to VFD's).
- G. Meter Physical Characteristics:
1. Display: Backlit LCD with antiglare and scratch-resistant lens.
 2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:
 - a. All meters, including those listed under the following:
 - 1) Measurements.
 - 2) THD.
 - 3) Energy.
 - 4) Demand.
 - 5) Minimum and maximum values.
 - 6) Power demand.
- H. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on all voltage and current channels of the meter.
- I. Meters:
1. Measurements: Instantaneous, in real time, rms to the 15th harmonic.
 - a. Voltage: L-L each phase, L-N each phase, and three-phase average.

- b. Current: Each phase, three-phase average, and neutral.
 - c. Unbalanced current, L-L V ac and L-N V ac.
 - d. Active Power (+/- kW): Each phase and three-phase total.
 - e. Reactive Power (+/- kVAR): Each phase and three-phase total.
 - f. Apparent Power (+/- kVA): Each phase and three-phase total.
 - g. Displacement Power Factor: Each phase and three-phase total.
 - h. Distortion Power Factor: Each phase and three-phase total.
 - i. Frequency.
 2. THD from measurements simultaneously from the same cycle, through 15th harmonic.
 - a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
 - b. Current THD: Each phase and three-phase average.
 - c. Total demand distortion.
 3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.
 - a. Active kWh.
 - b. Reactive kVARh.
 - c. Apparent kVAh.
 4. Demand: Present, last, predicted, peak.
 - a. Three-phase average current.
 - b. Three-phase total active power (kW).
 - c. Reactive power (kVAR).
 - d. Apparent power (kVA).
 5. Minimum and Maximum Values:
 - a. L-L and L-N voltages.
 - b. Current in each phase.
 - c. Power factor.
 - d. Active power total.
 - e. Reactive power total.
 - f. Apparent power total.
 - g. THD L-L and L-N voltages.
 - h. THD current in each phase.
 - i. Frequency.
- J. Power Demand, User Selectable:
 1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
 2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
 - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.

- b. Fixed block that calculates demand at end of the interval.
 - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
 - 3. Demand Calculation Initiated by a Synchronization Signal:
 - a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
 - b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
 - c. Provide for synchronizing the demand with the internal of this instrument.
- K. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.
 - 1. Minimum and maximum of real-time rms measurement.
 - 2. Energy.
 - 3. Demand values.
 - 4. Alarms, store the last 40 events.
- L. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm shall be user configured, by using the following options:
 - 1. Date and time stamp.
 - 2. Enable-disable (default) or enable.
 - 3. Pickup magnitude.
 - 4. Pickup time delay.
 - 5. Dropout magnitude.
 - 6. Dropout time delay.
 - 7. Alarm type.
 - 8. Alarm label.
- M. Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:
 - 1. Normal contact closure where the contacts change state for as long as the signal exists.
 - 2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
 - 3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.
- N. Meter Face:
 - 1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
 - 2. Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
 - 3. Provide for the reset of metered peak values.
- O. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:
 - a. Voltage: Measurements autoranging, 60- to 400-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
 - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
 - c. Frequency: 45 to 65 Hz.
 - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5 CIRCUIT METERS AND MONITORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Eaton.
 2. General Electric Company (GE Power).
 3. Schneider Electric USA, Inc.
 4. Siemens Industry, Inc., Energy Management Division.
- B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
 1. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 1. Indoor installation in non-air-conditioned nontemperature-controlled spaces that have environmental controls to maintain ambient conditions of **14 to 122 deg F** dry bulb and 20 to 90 percent relative humidity, noncondensing.
 2. Comply with IEC 60529 degree of protection code of IP52 for the front of the meter, and code of IP30 for the back.
- D. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.
- E. Accuracy:
 1. Comply with ANSI C12.20, Class 0.5.
 2. For Voltage and Current: 0.5 percent of reading.
 3. For Active Power: 0.2 percent.
 4. For Active and Reactive Energy: ANSI 12.20, Class 0.2.

5. For Frequency: 0.01 Hz in the range of 45 to 65 Hz.
6. For Power Factor: 0.2 percent from 0.5 leading to 0.5 lagging.

F. Data Links:

1. RS-485 Modbus RTU protocol, 2-wire connection.
2. RS-232/RS-485 Modbus RTU/ASCII protocol, 2-wire connection.
3. Modbus TCP:
 - a. 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
 - b. Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.
4. Provide for firmware and software updates through the communications port.
5. Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port.
6. Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port, Ethernet to serial line gateway, and embedded web server.
7. Profinet.

G. Meter Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

H. Sampling Rate:

1. Continuously sample and record voltage and current at a rate not less than 128 samples per cycle, simultaneously on all voltage and current channels of the meter.

I. Meters shall measure, record with time stamp, calculate, and on request display the following:

1. Measurements: Instantaneous, in real time, rms to the 63rd harmonic:
 - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - b. Current: Each phase, three-phase average, and neutral.
 - c. Active Power (kW): Each phase and three-phase total.
 - d. Reactive Power (kVAR): Each phase and three-phase total.
 - e. Apparent Power (kVA): Each phase and three-phase total.
 - f. Displacement Power Factor: Each phase and three-phase total.
 - g. Distortion Power Factor: Each phase and three-phase total.
 - h. Frequency.
2. THD from measurements simultaneously from the same cycle, through [31st] 63rd harmonic:

- a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - b. Current: Each phase, three-phase average, and neutral.
 3. Energy: Accumulated, indicate in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.
 - a. Active kWh.
 - b. Reactive kVARh.
 - c. Apparent kVAh.
 4. Demand: Three-phase totals, present, predicted, peak.
 - a. Average current.
 - b. Active power (kW).
 - c. Reactive power (kVAR).
 - d. Apparent power (kVA).
 5. Average, Minimum and Maximum Values:
 - a. Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.
- J. Power Demand, User Selectable:
1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
 2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
 - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
 - b. Fixed block that calculates demand at end of the interval.
 - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
 3. Demand Calculation Initiated by a Synchronization Signal:
 - a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
 - b. Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
 - c. Provide for synchronization to the clock in the instrument.
- K. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters.

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:
 - a. Every second for one minute for the one-minute curve.
 - b. Every minute for one hour for the one-hour curve.
 - c. Every hour for one day for the one-day curve.
 - d. Every day for one month for the one-month curve.
2. Forecast the trended parameters for the following:
 - a. The next four hours.
 - b. The next four days.

L. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated.
 - a. Capture, record with time stamp, and store voltage and current waveforms for two cycles.
 - b. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.
 - c. Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 63rd.
 - d. Captured waveforms shall be recorded from actual circuit performance.
2. Disturbance Waveform Capture:
 - a. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The waveform captures shall be user configurable from 185 cycles on 1 channel at 16 points per cycle, to 3 cycles on 6 channels at 128 points per cycle.

M. Disturbance Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.
 - a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
 - b. Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
 - c. When detecting an alarm condition:
 - 1) Initiate disturbance waveform capture.
 - 2) Record the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.

- 3) Alarm on shall be visible on the display and be transmitted over the data link.
- 4) Display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

N. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2. The current and voltage information for all phases shall be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

O. Alarms: Alarm events shall be user definable. Provide a minimum of 40 user-defined alarm conditions.

1. User Configuration Options:

- a. Date and time stamp.
- b. Enable-disable (default) or enable.
- c. Pickup magnitude.
- d. Pickup time delay.
- e. Dropout magnitude.
- f. Dropout time delay.
- g. Alarm type.
- h. Alarm label.

2. The following classes of events shall be available to be programmed as alarm events:

- a. Over/under current.
- b. Over/undervoltage.
- c. Current imbalance.
- d. Phase loss, current.
- e. Phase loss, voltage.
- f. Voltage imbalance.
- g. Over kVA.
- h. Over kW or kVAR into/out of load.
- i. Over/under frequency.
- j. Under power factor, true or displacement.
- k. Over THD.
- l. Over demand, current or power.
- m. Reverse power.
- n. Phase reversal.
- o. Status input change.
- p. End of incremental energy interval.
- q. End of demand interval.
- r. Over/under analog inputs.
- s. Current sag/swell.
- t. Voltage sag/swell.

3. For each over/under metered alarm value, provide for the user to define a pickup, dropout, and delay.
 4. The circuit meter and monitor alarms response time shall be not less than one second.
 5. Provide for up to four alarms to be combined to give a single result using Boolean algebra operations.
- P. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.
- Q. I/O Module: Modular, with multiple I/O options to accomplish specified performance and one or more spare positions for future.
1. KY Pulse: Generate a standard KY pulses for a user-defined increment of metered active energy as follows:
 - a. User-defined pulse output, associated with kWh.
 - b. Alarm pulse output, which turns on the pulsing at user-defined point.
 2. Digital Inputs: As follows:
 - a. One input connection rated 24- to 125-V ac or -V dc, +/- 10 percent, less than 5-mA burden, 1350-V rms isolation.
 - b. Six input connections rated 19- to 30-V dc, 5 mA maximum at 24-V dc. Provide an onboard 24-V dc power supply.
 - c. Two input connections rated 20- to 150-V dc or -V ac, 2 mA maximum.
 3. Analog inputs, no fewer than two, adjustable from 0- to 5-V dc or 4 to 20 mA.
 4. Outputs to operate field-installed relays, no fewer than two, providing 6- to 240-V ac or 6- to 30-V dc, 2 A rms. 5 A maximum for 10 seconds per hour.
 5. Analog outputs, no fewer than two, 4- to 20-mA dc into 600 ohms maximum.
- R. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.
1. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.
 - a. Each log entry shall hold data of up to 96 parameters each.
 - b. Each log shall be user configurable to log data at a different user-defined schedule interval.
 - c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
 - d. Configure log entries to be recorded as Fill & Hold or Circular (First in, First out, or FIFO), as defined by the user.
 2. Minimum/Maximum Logs:

- a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
 - b. Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the real-time metered values.
 3. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
 4. Waveform Logs: Capture and store waveforms, from 185 cycles on one channel at 16 samples per cycle, up to 3 cycles on six channels at 128 samples per cycle as defined by the user. Waveform log entries shall be externally triggered or forced in response to a user-defined event. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.
- S. Capacities and Characteristics:
1. Power Supply: 120-V ac, 60 Hz.
 2. Circuit Connections:
 - a. Voltage: Measurement autoranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
 - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
 - c. Frequency: 45 to 65 Hz.
 - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.6 CIRCUIT METER AND EXPLORER <Insert drawing designation>

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring, control, and power quality explorer; complying with UL 61010-1.
 1. Provide for metering 4-wire Y, 3-wire Y, and 3-wire delta power systems.
 2. Equip the instrument with security lock to protect revenue related metering from unauthorized and accidental changes.
- C. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in [**non-air-conditioned**] [**nontemperature-controlled**] spaces that have environmental controls to maintain ambient conditions of [**0 to 122 deg F**] <Insert **temperature range**> dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Comply with IEC 60529 degree of protection code of IP52.
3. The circuit meter and monitor shall meet UL 61010-1 overvoltage withstand rating of CAT IV.

D. Accuracy to the following plus/minus values:

1. Voltage and Current Meter: 0.04 percent of reading plus 0.025 percent of full scale.
2. Power and Energy Meter: 0.075 percent of reading plus 0.025 percent of full scale.
3. Energy Meter: Comply with ANSI C12.20, Class 0.20.
4. Frequency Meter: 0.01 Hz in the range of 45 to 67 Hz and accurate to 0.1 Hz in the range of 350 to 450 Hz.
5. Power Factor: 0.002 from 0.5 leading to 0.5 lagging.

E. Data Links:

1. RS-232 port.
2. RS-485 Modbus RTU protocol, [**2**] [**4**]-wire connection.
3. Ethernet Modbus/TCP/IP protocol:
 - a. 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
 - b. Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.
 - c. HTML server, with standard home page and five customizable pages.
4. Firmware and software updates shall be accessible through the communications port.
5. <Insert protocol>.

F. Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**] <Insert **number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

G. Sampling Rate:

1. Sample current and voltage to provide rms accuracy to 255th harmonic of the fundamental frequency of 60 Hz.
2. Continuously sample and record voltage and current at a rate not less than [**512 samples per cycle**] [**83,333 points per cycle**] <Insert **rate**>, simultaneously on all voltage and current channels of the meter.

H. Measure, record with time stamp, and calculate; and, on request, display the following:

1. Measurements: Instantaneous, in real time, rms to the 63rd harmonic:

- a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, L-N three-phase average, and percent unbalanced.
 - b. Current: Each phase, neutral, ground, three-phase average, apparent rms, and percent unbalanced.
 - c. Active Power (kW): Each phase and three-phase total.
 - d. Reactive Power (kVAR): Each phase and three-phase total.
 - e. Apparent Power (kVA): Each phase and three-phase total.
 - f. Displacement Power Factor: Each phase and three-phase total.
 - g. Distortion Power Factor: Each phase and three-phase total.
 - h. Frequency.
 - i. K-factor for each phase.
2. THD from measurements simultaneously from the same cycle, through [255th] <Insert number> harmonic:
 - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - b. Current: Each phase, three-phase average, and neutral.
 - c. Power: Active, reactive, and apparent power including power of up to [41st] <Insert number>.
3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.
 - a. Active kWh.
 - b. Reactive kVARh.
 - c. Apparent kVAh.
4. Demand:
 - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - 1) Present.
 - 2) Running average.
 - 3) Last completed interval.
 - 4) Peak.
 - b. Current: Each phase, three-phase average, and neutral.
 - 1) Present.
 - 2) Last completed interval.
 - 3) Minimum.
 - 4) Peak.
 - c. Active Power (kW): Three-phase totals.
 - 1) Last completed interval.
 - 2) Predicted.
 - 3) Peak.

- 4) Coincident with peak kVA demand.
 - 5) Coincident with peak kVAR demand.
 - d. Reactive Power (kVAR): Three-phase totals.
 - 1) Last completed interval.
 - 2) Predicted.
 - 3) Peak.
 - 4) Coincident with peak kW demand.
 - 5) Coincident with peak kVA demand.
 - e. Apparent Power (kVA): Three-phase totals.
 - 1) Last completed interval.
 - 2) Predicted.
 - 3) Peak.
 - 4) Coincident with peak kW demand.
 - 5) Coincident with peak kVA demand.
 - f. Distortion Power Factor: Three-phase totals.
 - 1) Last completed interval.
 - 2) Predicted.
 - 3) Peak.
 - 4) Coincident with peak kVA demand.
 - 5) Coincident with peak kVAR demand.
- I. Average, Minimum and Maximum Values:
 - 1. Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.
 - 2. Record, date and time stamp, and save maximum, minimum and average over a user-defined interval for the following metered values:
 - a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
 - b. Voltage Unbalance: L-L each phase and L-N each phase.
 - c. Current: rms each phase, three-phase average, and calculated neutral current.
 - d. Demand Current: rms each phase and three-phase average.
 - e. Current: Apparent, rms average.
 - f. Active Power (kW): Each phase and three-phase total.
 - g. Reactive Power (kVAR): Each phase and three-phase total.
 - h. Apparent Power (kVA): Each phase and three-phase total.
 - i. Demand Active Power: Each phase and three-phase total.
 - j. Demand Reactive Power: Each phase and three-phase total.
 - k. Demand Apparent Power: Each phase and three-phase total.
 - l. Accumulated Energy: MWh, MVAh, and MVARh.
 - m. Reactive energy (MVARh) by quadrant.
 - n. Power Factor: Three-phase displacement and distortion power factors.
 - o. K-factor for each phase.
 - p. THD L-L and L-N voltages.

- q. THD current in each phase and neutral.
- r. Frequency.

J. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
 - a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes. The default setting shall be the 15-minute continuous sliding block.
 - b. Fixed block that calculates demand at end of the interval.
 - c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
3. Demand Calculation Initiated by a synchronization signal. Synchronize demand with clock in the circuit meter and monitor.
 - a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
 - b. Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
 - c. Provide for synchronization to the clock in the instrument.
4. Record, date and time stamp, and save the following demand values of all rms metered values since the last reset, including the following:
 - a. Average demand current, per phase.
 - b. Peak demand current, per phase.
 - c. Average demand for active power, reactive power, and apparent power.
 - d. Predicted demand for active power, reactive power, and apparent power.
 - e. Peak demand for active power, reactive power, and apparent power.

K. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters:

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:
 - a. Every second for one minute for the one-minute curve.
 - b. Every minute for one hour for the one-hour curve.
 - c. Every hour for one day for the one-day curve.
 - d. Every day for one month for the one-month curve.
2. Forecast the trended parameters for the following:
 - a. The next four hours.

- b. The next four days.

L. Power Analysis Values:

1. THD Voltage: L-L each phase, L-N each phase, and L-N three-phase average.
2. THD Current: Each phase, three-phase average, and neutral current.
3. Total demand distortion.
4. K-factor for each phase.
5. Crest factor, each phase.
6. Displacement power factor.
7. Fundamental voltage, magnitude and angle, each phase.
8. Fundamental currents, magnitude and angle, each phase.
9. Fundamental active power, each phase and three-phase total.
10. Fundamental reactive power, each phase and three-phase total.
11. Harmonic power, each phase and three-phase total.
12. Phase rotation.
13. Voltage and current unbalances.
14. Harmonic magnitudes and angles, each phase.
15. Distortion power.
16. Distortion power factor.

M. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated over the communications network.
 - a. Capture, record with time stamp, and store voltage and current waveforms at a user-defined resolution of 16 to 512 samples/cycle for up to 30 seconds.
 - b. Capture, record with time stamp, and store 512 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.
 - c. Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 255th for the following:
 - 1) Voltage: L-N and L-G each phase.
 - 2) Current: Of each phase and neutral current.
 - d. Captured waveforms shall be recorded from actual circuit performance.
2. Disturbance Waveform Capture:
 - a. Capture, record with time stamp, and store digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The captured waveform shall be at a user-defined resolution of 16 to 512 samples/cycle per second. The number of pre-alarm cycles shall be adjustable.
3. Waveform samples shall be available for transmission over the communications network, for display, archival, and analysis at computer workstations.

N. Transient Detection.

1. Detect and capture transient voltage surge events up to 10 kV L-L with a duration as short as 200 ns.
- O. Flicker Detection.
1. Detect and capture flicker events, defined by IEEE 1453, at three levels: instantaneous, short term, and long term.
 2. Display the flicker event as plots of magnitude versus time on semi-log graph background.
- P. Sag and Swell Detection and Alarm:
1. Detect and initiate alarm when detecting voltage or current sag and swell.
 - a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
 - b. Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
 - c. When detecting an alarm condition:
 - 1) Initiate disturbance waveform capture.
 - 2) Initiate 100-ms event recording.
 - 3) Recording the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
 - 4) Causing an alarm on the display and transmit the alarm over the data link.
 - 5) The user shall have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.
- Q. 100-ms Event Recording: Capture, record with time stamp, and store.
1. Initiate recording by an alarm or external contact closure.
 2. User-configured recording, to record for the duration of the alarm up to 300 seconds and can be delayed for 1 to 10 seconds.
 3. Records current per-phase and neutral, voltage L-L each phase and L-N each phase, active power per-phase and three-phase total, reactive power each phase and three-phase total, apparent power each phase and three-phase total, and true power factor three-phase total.
 4. Operate an output relay in the I/O module of the instrument.
- R. Harmonics Information:
1. Calculate the harmonic magnitudes and angles for each phase voltage and current in each phase and neutral, through the 255th harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
 2. The current and voltage information for all phases shall be obtained simultaneously from the same cycle.

3. Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

S. Alarms:

1. Alarm events may be either user defined or preconfigured by manufacturer from the applicable standards. Provide for multiple levels for each alarm that is based on metered data.
2. The instrument shall calculate the listed key electrical parameters at not less than 100-ms intervals to initiate and record an alarm event. Provide for user-selected range of 1 to 10 seconds of pre-event and up to five minutes of post-event data recording.
3. The following classes of events shall be available to be programmed as alarm events:
 - a. Over/under current.
 - b. Over/undervoltage.
 - c. Current imbalance.
 - d. Phase loss, current.
 - e. Phase loss, voltage.
 - f. Voltage imbalance.
 - g. Wave shape alarm.
 - h. Over kVA.
 - i. Over kW or kVAR into/out of load.
 - j. Over/under frequency.
 - k. Under power factor, true or displacement.
 - l. Over THD.
 - m. Over K-factor.
 - n. Over demand, current or power.
 - o. Reverse power.
 - p. Phase reversal.
 - q. Status input change.
 - r. End of incremental energy interval.
 - s. End of demand interval.
 - t. Over/under analog inputs.
 - u. Current sag/swell.
 - v. Voltage sag/swell.
 - w. Transient events.
4. For each over/under metered alarm value, the user shall define a pickup, dropout, and delay.
5. Waveform Alarms:
 - a. The instrument shall detect anomalous waveform events that are less than half-cycle in length.
 - b. Provide for the user to set a threshold value and an upper limit to determine whether the waveform triggers an alarm. The threshold value and upper limit shall be a value between 1 and 100. The threshold value is the limit at which a waveform triggers the alarm. The upper limit defines the highest waveform value that triggers a waveform alarm. The settable values are as follows:
 - 1) Phase voltages.
 - 2) N-G voltages.

- 3) Phase currents.
 - 4) Neutral currents.
- c. In response to a waveform alarm, the instrument shall:
 - 1) Log the event and record phase currents and voltages as defined in the 100-ms event recording.
 - 2) Determine the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, or high) of the accuracy of the source location.
6. Provide four alarm severity levels to allow the user to respond to the most important events first.
7. Indicate an alarm condition on the front panel of the instrument, as well as reported over the data link to designated workstations.
8. The circuit meter and monitor alarms response time shall be not less than the following:
 - a. Standard, one second.
 - b. High speed, 100 ms.
 - c. Disturbance, half-cycle.
9. Up to four alarms may be combined to give a single result using Boolean algebra operations.
10. Provide e-mail notification of alarm conditions.
11. Automatic Alarm Set-Point Adjustment:
 - a. The instrument software shall provide for recognizing and learning the characteristics of the normal operation of the electrical power system it is connected to, and to select and adjust alarm set points based on that recognition.
 - b. The metered data to be recognized and learned, and the period of time for learning for alarms, disturbances, and waveform alarms, shall be set by the user by selection one of the following two modes:
 - 1) Fixed Learning: Initially configured user set points are used during the entire learning period.
 - 2) Dynamic Learning: Initially configured user set points are temporarily replaced by learned set points at the interval specified by the user in the learning setup. The set points continue to be updated at the specified interval until the learning period expires.
 - c. The learning period shall be user configurable. If the learned set points do not change over a predefined period, the learning process can be stopped and the set points either installed or held for review.
- T. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.
- U. I/O Module: Modular, with multiple I/O options, programmable to accomplish specified performance and one or more spare positions for future. At minimum, the instrument shall provide the following:

1. KYZ Pulse: Solid-state output relay, programmed to generate a standard KYZ pulses for a user-defined increment of metered active energy as follows:
 - a. User-defined pulse output, associated with kWh.
 - b. Alarm pulse output, which turns on the pulsing at user-defined point.
2. Digital inputs, each having the following operating modes:
 - a. Normal: Simple on/off digital inputs.
 - b. Demand Interval Synch Pulse Accept a demand synch pulse from a utility demand meter.
 - c. Conditional Energy Control input to control conditional energy accumulation.
3. Output Relays and Control: Output relays shall have normally open and normally closed contacts and shall operate in response to a user sent command over the data link, or automatically responding to an alarm event. The relays shall be user configured in one of the following listed modes:
 - a. Normal contact closure where the contacts change state for as long as the signal exists.
 - b. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
 - c. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.
 - d. End of Power Demand Interval: When the relay operates as a synch pulse for other devices.
 - e. Energy Pulse Output: Relay will pulse quantities used for Absolute kWh, Absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
 - f. Programmed Output: Relay will operate in response to multiple alarms that are arranged to give a single result using Boolean algebra operations.

V. Onboard Data Logs:

1. Log data, alarms and events, and waveforms in onboard solid-state nonvolatile memory.
2. Onboard data logs shall be available for transmission over the communications network for display, archival, and analysis at computer workstations on demand.
3. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.
 - a. Each log entry shall hold data of up to 96 parameters each.
 - b. Each log shall be user configurable to log data at a different user-defined schedule interval.
 - c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
 - d. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.
4. Minimum/Maximum Logs:

- a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
 - b. Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the active-time metered values.
 5. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. The log capacity shall be not less than 1000 events. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
 6. Waveform Logs: Capture and store waveforms as follows:
 - a. One cycle, 512 samples, to the 255th harmonic. Manually triggered.
 - b. Adjustable from 8 seconds at 18 samples per cycle, to 264 seconds at 16 samples per cycle. Triggered manually or by a user set alarm.
 - c. Voltage sampling at 5 MHz (83,333 samples per cycle) more than 2 ms to capture transient peaks of less than 1 microsecond.
- W. Programming: Programming of instrument functions shall be similar to BASIC syntax. Provide for initial programming and changes to programs through the communications links.
1. Programming language shall include the following capabilities:
 - a. Scheduled tasks.
 - b. Event tasks.
 - c. Math functions including add, subtract, multiple, divide, sine, cosine, and square root.
 - d. Logical functions including: AND, OR, XOR, NOT, shift, and so forth.
 - e. Loop commands.
 - f. Compare statements.
 - g. Counters and timers.
 2. Manufacturer shall provide custom programs to meet Project requirements that are described in the "Capacities and Characteristics" Paragraph.
 3. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
 4. Data reduction using smart data logging.
 5. Automatic monthly logging/reset of kWh and peak demand.
 6. Statistical profile analysis of metered quantities.
 7. ITIC/SEMI power quality analysis.
 8. Calculations for IEEE 519 verification.
 9. Metering of combined utilities: gas, water, steam, and electric.
 10. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions, for example, time of day and input status.
- X. Capacities and Characteristics:
1. Power Supply: **[120-V ac, 60 Hz]** <Insert text>.
 2. Circuit Connections:

- a. Voltage: Measurements autoranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. **[Connect directly to low-voltage (600 V and less) without using voltage transformers.] [Connect to instrument grade potential transformers secondary at 120 V.]** Meter impedance shall be 2-megohm L-L or greater.
 - b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 15 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
 - c. Frequency: 45 to 67 Hz, and 350 to 450 Hz.
 - d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.
3. Onboard, Field-Upgradeable, Solid-State Nonvolatile Memory: **[8] <Insert number> MB.**
 4. Number of Onboard Data Logs: **[14] <Insert number>.**
 5. Number of Minimum/Maximum Log Files: **[Two] <Insert number>.**
 6. Alarm Log Capacity: Not less than 1000 events.
 7. Custom Programs: Provide the following programs with the instrument:
 - a. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
 - b. Data reduction using smart data logging.
 - c. Automatic monthly logging/reset of kWh and peak demand.
 - d. Statistical profile analysis of metered quantities.
 - e. Calculations for IEEE 519 verification.
 - f. Metering of combined utilities: gas, water, steam, and electric.
 - g. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions such as time of day and input status.
 - h. **<Insert requirements>.**

2.7 PC OPERATING SYSTEM SOFTWARE

- A. Description: System software shall monitor, analyze, display, control, and save all the parameters and features available at the connected meter.
- B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.
- C. Minimum Requirements:
 1. Real-time multitasking and multiuser **[32-] [or] [64-]**bit operating system that allows execution of multiple real-time programs and custom program development.
 2. Operating system shall be capable of operating Microsoft Windows applications.
 3. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

2.8 NETWORKED PC OPERATING SYSTEM SOFTWARE

- A. Description: System software shall monitor, analyze, display, control, and save parameters and features available at each of the connected meters.
- B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be web enabled.
- C. System Software Minimum Requirements:
 - 1. Real-time multitasking and multiuser [~~32-~~] [or] [~~64-~~]bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
 - 2. Operating system shall be capable of operating Microsoft Windows applications.
 - 3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
 - 4. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.
- D. Operator Interface Software:
 - 1. Minimize operator training through use of English language prorating and English language point identification.
 - 2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
 - 3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
 - 4. Automatic sign-off period shall be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
 - 5. Record operator sign-on and sign-off activity.
 - 6. Security Access:
 - a. Operator access to electrical monitoring and control system shall be under password control.
 - b. An alphanumeric password shall be user assignable to each operator.
 - c. Software shall have at least five access levels.
 - 1) View - View information. No change privileges allowed.
 - 2) User - Same as View, but is able to initiate control functions.
 - 3) Controller - Same as User, but is able to initiate communications.
 - 4) Operator - Same as Controller, but is able to modify configurations.
 - 5) Supervisor - Same as Operator, but is able to administer security privileges.
 - d. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
 - e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

E. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such shall be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.9 POWER MONITORING AND CONTROL SOFTWARE

A. Data Storage and Data Sharing:

1. Query and download logs of interval data stored on metering devices.
2. Query and download logs of alarm and event data stored on metering devices.
3. Query and download logs of waveform capture data stored on metering devices.
4. Query and download logs of interval data generated by the software and calculated by the meters.
5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
6. Automatically re-arm the waveform recorders, on upload of information.
7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
8. Provide a facility to view historical data from archived databases.
9. Support user changes to the database.
 - a. Support on-line changes while the data storage/retrieval application is running.
 - b. Suffer no interruption to its operation while changes are being made.
 - c. Require no restart once the configuration has been performed.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2. Plan for each building floor, showing the following:
 - a. Locations and identification of all monitored and controlled electrical equipment.
 - b. **<Insert requirements>**.
3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation[, **similar to that indicated on Drawings,**] with device identification.
4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, **[gateways] [and] [other network devices]**.

2.10 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:

1. Add and remove devices in the power monitoring and control network.
2. Application for naming devices based on a user-defined naming scheme.
3. Add and remove I/O servers in the power monitoring and control network.
4. Edit communication properties for devices including timeouts and delays.
5. Display mandatory fields when adding a new device.
6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
8. Pool modem resources so that the software uses any available modem.
9. Monitor the following diagnostics:
 - a. Communication request/response and error rates, and timeouts.
 - b. Log acquisition services.

B. Database Maintenance Features:

1. Backup, archive, and trim data, event, and waveform logs.
 - a. Record start and end date for operation.
 - b. Allow copying data to another database.
 - c. Be capable of selecting any or all of the logs specified for the meters that are Work of this Section.
 - 1) Data logs.
 - 2) Event logs.
 - 3) Waveform logs.

C. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

1. Features:
 - a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
 - b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
 - c. Distribution of reports via email.
2. Report on power and demand profiles.
3. Power quality report with CBEMA evaluation.
4. EN 50160 compliance report.
5. 100-ms PQ report.
6. Energy over Period Report:
 - a. User-defined rollup interval by day, week, month, or year.
 - b. Compare daily energy to the following:

- 1) Previous day.
 - 2) Same day, previous week.
 - 3) Same day, previous month.
 - 4) User-defined specific day.
 - c. Compare weekly energy to the following:
 - 1) Previous week.
 - 2) Same week from previous month.
 - 3) Same week from previous year.
 - 4) User-defined specific week.
 - d. Compare monthly energy to the following:
 - 1) Previous month.
 - 2) Same month from previous year.
 - 3) User-defined specific month.
 - e. Compare annual energy to the following:
 - 1) Previous year.
 - 2) User-defined specific year.
7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
9. Trend Report:
 - a. Show values for multiple measurements and measurements from multiple devices in any of the following graphical formats:
 - 1) Line chart.
 - 2) Pie graph.
 - 3) Bar chart.
 - 4) Column chart.
 - 5) Smooth line chart.
 - 6) Stacked column chart.
 - 7) Stacked bar chart.
10. Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
11. System Configuration Report:
 - a. Device name.
 - b. Device type.
 - c. Device address.
 - d. Connection status.
 - e. Device protocol.
 - f. Device description.

12. Each default report shall include the following:
 - a. Summary aggregation of data from the selected devices.
 - b. Individual device information.
 - c. Raw data.
13. The reporting tool shall provide a graphical interface to create and manage multiple Time of Use schedules:
 - a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
 - b. Off-peak and on-peak times.

2.11 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

- A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.
- B. Instrument Transformers: Comply with IEEE C57.13.
 1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
 2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.
- C. Ethernet Connectivity:
 1. A multipoint, RS-485 Modbus serial communications network shall be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
 2. Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.
 3. Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.
- D. Ethernet Gateways:
 1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
 2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Owner.
 3. Common Gateway Features:
 - a. User configurable, with secure password-protected login process.
 - b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
 - c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's RS-485 port(s) through a standard web browser.

- d. Allow firmware upgrades through the communications port.
 - 4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
 - 5. Implement a common user interface ("look and feel") across all styles of power equipment.
- E. Distribution Equipment Monitoring:
- 1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
 - 2. Display Data:
 - a. Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).
 - b. Load current summary page to display circuit name, and phase a, b, and c rms current values.
 - c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
 - d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
 - e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
 - f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
 - g. For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.12 SYSTEM OPERATOR INTERFACES

- A. Operator means of system access shall be through the following:
- 1. Desktop workstation with hardwired connection through LAN port.
 - 2. Portable terminal with hardwired connection through LAN port at each meter.
 - 3. Remote connection using outside of system PC, tablet, or phone using an internet portal.

2.13 RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
- B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.14 WIRES AND CABLES

- A. Electrical Power Wiring: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Copper conductors are Type THHN/THWN-2.
- B. Control Wiring: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
 - 1. Optical-Fiber Cable: Multimode, 50/125-micrometer OM3, six-fiber, tight-buffer, optical-fiber cable, with aqua jacket.
 - 2. Balanced Twisted Pair Cable: 100-ohm, four-pair Category 6.
 - 3. Workstation Outlets: Four-port-connector assemblies mounted in single or multigang faceplate. Coordinate color and labels with Section 262726 "Wiring Devices."
 - 4. RS-485 Cable: Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
 - 5. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
 - a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
 - b. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
 - c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.
- C. RS-232 Cable:
 - 1. PVC-Jacketed, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - a. Type CM.
 - b. Flame Resistance: UL 1581, vertical tray.
 - 2. Plenum-Type, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - a. Type CMP.
 - b. Flame Resistance: NFPA 262, flame test.

2.15 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Protection Technologies Inc. (APT).
 - 2. Eaton.

3. [LEA International.](#)
 4. [PowerLogics, Inc./PQ Protection.](#)
 5. [Schneider Electric USA, Inc.](#)
 6. [Siemens Industry, Inc., Energy Management Division.](#)
- B. SPDs: Comply with UL 1449, Type 1.
1. Include LED indicator lights for power and protection status.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.
- D. Comply with UL 1283.
- E. Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. L-N: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
 2. L-G: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
 3. N-G: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
 4. L-L: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.
- F. SCCR: Equal or exceed 100 kA.
- G. Nominal Rating: 20 kA.
- H. Indoor Enclosures: NEMA 250, Type 1.
- I. Outdoor Enclosures: NEMA 250, Type 4X.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
- C. 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.
- D. Wiring and Cabling Installation:
 - 1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
 - 2. Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.
- E. Raceways Installation:
 - 1. Comply with Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
 - 2. Comply with Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.
- F. Identification Installation:
 - 1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
 - 2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, RS-485 cable, low-voltage control cable, and RS-232 cable.
 - 3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

3.3 WORKSTATION INSTALLATION

- A. Desktop Workstations Installation:
 - 1. Install workstation(s) at location(s) directed by Owner.
 - 2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
 - 3. Install software on workstation(s) and verify that software functions properly.
 - 4. Develop Project-specific graphics, trends, reports, logs, and historical database.
 - 5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.
- B. Portable Workstations Installation:
 - 1. Turn over portable workstations to Owner at Substantial Completion.

2. Install software on workstation(s) and verify that software functions properly.

C. Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Engineer's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the system operation and maintenance manual.

3.4 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.5 GROUNDING

- A. For data communication wiring, comply with NECA/BICSI 568.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
5. Optical-Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.
 - 2) Attenuation test results for links shall be less than that calculated according to equation in TIA-568-C.0.
 - c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
6. Power Monitoring and Control System Tests.
 - a. Test Analog Signals:
 - 1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 - 2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 - 3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.
 - b. Test Digital Signals:
 - 1) Check digital signals using a jumper wire.
 - 2) Check digital signals using an ohmmeter to test for contact making or breaking.
 - c. I/O Control Loop Tests:

- 1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
- 2) Test every I/O point throughout its full operating range.
- 3) Test every control loop to verify that operation is stable and accurate.
- 4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
- 5) Test and adjust every control loop for proper operation according to sequence of operation.
- 6) Test software and hardware interlocks for proper operation.
- 7) Operate each analog point at the following:
 - a) Upper quarter of range.
 - b) Lower quarter of range.
 - c) At midpoint of range.
- 8) Exercise each binary point.
- 9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument shall match.
- 10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

D. Wiring and cabling will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 FINAL REVIEW

- A. Submit written request to Engineer when the power monitoring and control system is ready for final review. Written request shall state the following:
 1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
 2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
 3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
 4. The system is complete and ready for final review.
- B. Review by [Engineer] will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

- D. Final review shall include a demonstration to parties participating in final review.

3.8 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the power monitoring and control system.
- B. Extent of Training:
 - 1. Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
 - 2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
 - 3. Minimum Training Requirements:
 - a. Provide no fewer than two days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
 - c. Total days of training shall be broken into not more than two separate training classes.
- C. Attendee Training Manuals:
 - 1. Provide each attendee with a color hard copy of all training materials and visual presentations.

2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
 3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.
- D. Instructor Requirements:
1. One or multiple qualified instructors, as required, to provide training.
 2. Instructors shall have no fewer than five years of providing instructional training on no fewer than five past projects with similar electrical monitoring and control system scope and complexity.
- E. Training Outline: Submit training outline for Owner review at least 10 business days before scheduling training. Outline shall include a detailed agenda for each training day that is broken down into each training session that day, training objectives for each training session, and synopses for each lesson planned.
- F. On-Site Training:
1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
 2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
 3. Provide as much of training located on-site as deemed feasible and practical by Owner.
 4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
 5. The workstation provided with the system shall be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.
- G. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
 2. Provide capability to remotely access to Project monitoring and control system for use in training.
 3. Provide a workstation for use by each attendee.
- 3.11 At Completion of Training:
- A. Staff familiar with the system installed are capable of demonstrating operation of the system during final review.
- B. Demonstration shall include, but not be limited to, the following:
1. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance

- requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
 3. Trends, summaries, logs, and reports set-up for Project.
 4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
 5. Software's ability to edit control programs off-line.
 6. Data entry to show Project-specific customizing capability including parameter changes.
 7. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
 8. Execution of digital and analog commands in graphic mode.
 9. Spreadsheet and curve plot software and its integration with database.
 10. Online user guide and help functions.
 11. For Each Meter:
 - a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
 - b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
 - c. Wiring Labels: Match control drawings.
 - d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
 - e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.
 12. For Each Workstation:
 - a. I/O point lists agree with naming conventions.
 - b. Graphics are complete.
 - c. UPS unit, if applicable, operates.

END OF SECTION 260913

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Switchbox-mounted occupancy sensors.
4. High-bay occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

- B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

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

- B. Shop Drawings:

1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which equipment will be attached.
3. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Control modules.

- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control devices.
 2. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. Legrand.
 4. Leviton Manufacturing Co., Inc.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
 2. Contact Configuration: SPST DPST or DPDT where required.
 3. Contact Rating: 30-A inductive or resistive, 240-V ac, 20-A ballast or LED driver load, 120-/240-V ac.
 4. Programs: Eight on-off set points on a 24-hour schedule.

5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
6. Astronomic Time: All channels.
7. Automatic daylight savings time changeover.
8. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, LUMINAIRE-MOUNTED

- A. "Description" Paragraph below describes a device with less-effective surge protection, having a fixed load-breaking contact capacity. Its main application is control of a single lighting luminaire. It is designed for mounting on a luminaire.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA inductive, to operate connected load, complying with UL 773, and compatible with CFL and LED lamps.
 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with ANSI C136.10, with base from same source and manufacturer as switch.
 6. Failure Mode: Luminaire stays ON.

2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Industries, Inc.
 2. Hubbell Incorporated (Hubbell Control Solutions).
 3. Legrand North America, LLC (WattStopper).
 4. Lithonia Lighting; Acuity Brands Lighting, Inc.
 5. Sensor Switch, Inc.
- B. General Requirements for Sensors:
 1. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 2. Dual technology.
 3. Integrated power pack.
 4. Hardwired connection to switch.
 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

- b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - 7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
 - 8. Power: Line voltage.
 - 9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 10. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 12. Bypass Switch: Override the "on" function in case of sensor failure.
 - 13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
- 1. Sensitivity Adjustment: Separate for each sensing technology.
 - 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 - 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 - 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

2.4 OUTDOOR MOTION SENSORS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
- 1. [Cooper Industries, Inc.](#)
 - 2. [Hubbell Incorporated \(Hubbell Control Solutions\).](#)
 - 3. [Legrand North America, LLC \(WattStopper\).](#)

4. Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Description: Solid-state outdoor motion sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. PIR type, weatherproof. Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.. Comply with UL 773A.
3. Switch Rating:
 - a. Luminaire-Mounted Sensor: 1000-W incandescent, 500-VA fluorescent/LED.
 - b. Separately Mounted Sensor: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
4. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off." With bypass switch to override the "on" function in case of sensor failure.
5. Voltage: Match the circuit voltage type.
6. Detector Coverage:
 - a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft..
 - b. Long Range: 180-degree field of view and 110-foot detection range.
7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
8. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
9. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and help eliminate false "off" switching.
11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F, rated as "raintight" according to UL 773A.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

- A. Comply with NECA 1.
- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16

"Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."

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

END OF SECTION 260923

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Seismic Qualification Data: Certificates, for transformers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - 4. Certification: Indicate that equipment meets Project seismic requirements.

- C. Source quality-control reports.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB/GE.
 - 2. Eaton.
 - 3. Schneider Electric USA (Square D).
 - 4. Siemens Industry, Inc., Energy Management Division.
- B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."

2.3 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Comply with NFPA 70.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 - 3. Grounded to enclosure.
- D. Coils: Continuous windings without splices except for taps.
 - 1. Coil Material: Copper.
 - 2. Internal Coil Connections: Brazed or pressure type.
 - 3. Terminal Connections: Bolted.
- E. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

- F. Enclosure: Ventilated.
 - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 - 4. Finish: Comply with NEMA 250.
 - a. Finish Color: ANSI 49 gray weather-resistant enamel.
- G. Taps for Transformers 3 kVA and Smaller: None.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- J. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.
- L. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- M. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
- N. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding the shield.
- O. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
- P. Wall Brackets: Wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.

- Q. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: 40 dBA.
2. 9.01 to 30.00 kVA: 45 dBA.
3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9.
4. 50.01 to 150.00 kVA: 50 dBA for K-factors of 1, 4, and 9.

2.5 IDENTIFICATION

- A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."
- B. Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
 2. Ratio tests at rated voltage connections and at all tap connections.
 3. Phase relation and polarity tests at rated voltage connections.
 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 6. Applied and induced tensile tests.
 7. Regulation and efficiency at rated load and voltage.
 8. Insulation-Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated from design drawings signed and sealed by a licensed structural engineer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
 - 2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions[, **seismic codes applicable to Project,**] and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- 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. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Perform specific inspections and mechanical tests recommended by manufacturer.
 - f. Verify that as-left tap connections are as specified.
 - g. Verify the presence of surge arresters and that their ratings are as specified.
 - 2. Electrical Tests:
 - a. Measure resistance at each winding, tap, and bolted connection.
 - b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
 - d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- F. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, and grounding.
- c. Verify that resilient mounts are free and that any shipping brackets have been removed.
- d. Verify the unit is clean.
- e. Perform specific inspections and mechanical tests recommended by manufacturer.
- f. Verify that as-left tap connections are as specified.
- g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

- a. Measure resistance at each winding, tap, and bolted connection.
- b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
- c. Perform power-factor or dissipation-factor tests on all windings.
- d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
- e. Perform an excitation-current test on each phase.
- f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
- g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

G. Remove and replace units that do not pass tests or inspections and retest as specified above.

H. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

I. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than

nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262218 - LOW-VOLTAGE TRANSFORMERS FOR LOAD CENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes transformers load centers.
- B. Related Sections:
 - 1. Section 260526 - Grounding and Bonding for Electrical Systems.
 - 2. Section 260529 - Hangers and Supports for Electrical Systems.
 - 3. Section 260533 - Raceway and Boxes for Electrical Systems.
 - 4. Section 260553 - Identification for Electrical Systems.
 - 5. Section 262200 - Low-Voltage Transformers.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, rated temperature rise, panel schedule, and short circuit withstand rating of the assembly.

1.4 CLOSEOUT SUBMITTALS

- A. Section 017700 - Closeout Procedures : Closeout procedures.
- B. Project Record Documents: Record actual locations of transformer load centers.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years [**documented**] experience.

1.6 COORDINATION

- A. Section 013100 - Project Management and Coordination : Coordination and project conditions.

- B. Coordinate Work with installation of concealed bracing in walls to support transformers.

PART 2 - PRODUCTS

2.1 TRANSFORMER LOAD CENTERS

- A. Manufacturers:
 - 1. Eaton
 - 2. Schneider Electric USA
 - 3. Siemens
 - 4. Substitutions: Section 016000 - Product Requirements.
- B. Product Description: NEMA ST 20, transformer distribution unit with integral primary, secondary, and branch circuit breakers.
- C. Primary Voltage: As indicated on the drawings.
- D. Secondary Voltage: As indicated on the drawings.
- E. Molded Case Circuit Breakers: UL 489, plug-on type thermal magnetic trip circuit breakers, with common trip handle for poles, listed as Type SWD for lighting circuits, Class A ground fault interrupter circuit breakers where indicated. Do not use tandem circuit breakers.
- F. Short circuit withstand rating: As indicated on the panel schedules.
- G. Enclosure: NEMA ST 20, **Type 3R** ventilated **and** Suitable for the environment in which the transformer is installed as shown on the electrical area classification drawings. Furnish lifting eyes or brackets
- H. Mounting: Wall.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013100 - Project Management and Coordination : Coordination and project conditions.
- B. Verify mounting supports are properly sized and located, including concealed bracing in walls.

3.2 EXISTING WORK

- A. Disconnect and remove abandoned transformer load centers.
- B. Maintain access and adequate ventilation to existing transformer load centers and other installations remaining active and requiring access and ventilation. Modify installation or provide access panel or ventilation grilles.

- C. Clean and repair existing transformer load centers to remain or to be reinstalled.

3.3 INSTALLATION

- A. Set transformer load center plumb and level.
- B. Use flexible conduit, in accordance with Section 260533, 2 feet minimum length, for connections to unit case. Make conduit connections to side panel of enclosure.
- C. Height: 6 feet to top of load center.
- D. Provide typed circuit directory for each branch circuit load center. Revise directory to reflect circuiting changes required to balance phase loads.
- E. Install engraved plastic nameplates in accordance with Section 260553.
- F. Support units in accordance with Section 260529. Mount using integral flanges or accessory brackets furnished by manufacturer.
- G. Install grounding and bonding in accordance with Section 260526.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements 017300 - Execution: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform transformer inspections and tests listed in NETA ATS, Section 7.2.1.
- D. Perform load center inspections and tests listed in NETA ATS, Section 7.6.1.1.

3.5 ADJUSTING

- A. Section 017300 - Execution: Testing, adjusting, and balancing.
- B. Measure primary and secondary voltages and make appropriate tap adjustments.

END OF SECTION 262218

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.
8. Mimic bus.

- B. Related Requirements

1. Section 260573 "Power System Studies" for arc-flash analysis and arc-flash label requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

- B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.

7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
10. Include diagram and details of proposed mimic bus.
11. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Delegated Design Submittal:

1. For arc-flash hazard analysis.
2. For arc-flash labels.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components 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. Routine maintenance requirements for switchboards and all installed components.
 - b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Testing Agency Qualifications: Accredited by NETA.
 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Remove loose packing and flammable materials from inside switchboards and connect factory-installed space heaters to temporary electrical service to prevent condensation.
- C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 FIELD CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations:
 1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period (applicable to Wilson Blvd only as 118th Switchboard is in outdoor enclosure).
 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- C. Unusual Service Conditions: NEMA PB 2, as follows:
 1. Ambient temperatures within limits specified.
 2. Altitude not exceeding 6600 feet.

- D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 2. Indicate method of providing temporary electric service.
 3. Do not proceed with interruption of electric service without Owner's written permission.
 4. Comply with NFPA 70E.

1.10 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Three years from date of Substantial Completion.
- B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
 2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. Schneider Electric USA (Square D).
 - 3. Siemens Industry, Inc., Energy Management Division.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Sections front and rear aligned.
- I. Front- and Side-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Section Alignment: Front and Rear aligned.
- J. Nominal System Voltage: 480Y/277 V.
- K. Main-Bus Continuous: 1200 A (118th Street) 800 A (Wilson Blvd).
- L. Indoor Enclosures: Steel, NEMA 250, Type 1.
- M. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- N. Outdoor Enclosures: Type 3R (118th Street only).
 - 1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
 - 2. Enclosure: Downward, rearward sloping roof; rear hinged doors for each section, with provisions for padlocking.
 - 3. Accessories: LED luminaires, ceiling mounted; wired to a three-way light switch;
 - 4. Heating and Ventilating:

- a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F with outside design temperature of 0 deg F.
 - b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F with outside design temperature of 115 deg F.
 - c. Ventilating openings complete with replaceable fiberglass air filters.
 - d. Thermostat: Single stage; wired to control heat and exhaust fan.
5. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer, with spare capacity of 25 percent, within the switchboard. Supply voltage shall be 120 V ac.
6. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.
- O. Barriers: Between adjacent switchboard sections.
- P. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- Q. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 2. Space-Heater Power Source: Transformer, factory installed in switchboard.
- R. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.
- S. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- T. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- U. Removable, Hinged Rear Doors and Compartment Covers: Secured by captive thumb screws, for access to rear interior of switchboard.
- V. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- W. Buses and Connections: Three-phase, four-wire, unless otherwise indicated.
 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
 2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, [tin-plated].

3. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with compression connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with compression connectors for feeder and branch-circuit ground conductors.
 5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 6. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
 7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with compression connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- X. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- Y. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 130 deg C. Busbars shall be coated in a minimum 32mm layer of red epoxy. Final connections shall be booted with epoxy.
- Z. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.3 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. ABB/GE.
 2. Advanced Protection Technologies Inc. (APT).
 3. Eaton.
 4. Schneider Electric USA (Square D).
 5. Siemens Industry, Inc., Energy Management Division.
- B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- C. Features and Accessories:
1. Integral disconnect switch.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.

3. Indicator light display for protection status.
 4. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status.
 5. Surge counter.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
 2. Line to Ground: 1200 V for 480Y/277 V.
 3. Line to Line: 2000 V for 480Y/277 V.
- F. SCCR: Equal or exceed 200 kA.
- G. Nominal Rating: 20 kA.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- a.
- B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
1. Drawout circuit-breaker mounting.
 2. Two-step, stored-energy closing.
 3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Time adjustments for long- and short-time pickup.
 - c. Ground-fault pickup level, time delay, and I squared t response.
 4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking phase-fault and ground-fault protection function.
 5. Remote trip indication and control.
 6. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format). Provide functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 8. Control Voltage: 120-V ac.

2.5 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: ANSI Standard C57.13; 120 V, 60 Hz, tapped double secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 2. Current Transformers: ANSI C57.13; 5 A, 60 Hz, secondary; bushing [**bar or window**] type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Analog Meters:
1. Meters: 4-inch diameter or 6 inches square, flush or semiflush, with anti-parallax 250-degree scales and external zero adjustment.
- D. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
- E. Instrument Switches: Rotary type with off position.
1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and, where a neutral is indicated, phase-to-neutral voltages.
 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.
- F. Ammeters: 2-1/2-inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for indicated feeder circuits only.

G. Watt-Hour Meters and Wattmeters:

1. Comply with ANSI C12.1.
2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
3. Suitable for connection to three- and four-wire circuits.
4. Potential indicating lamps.
5. Adjustments for light and full load, phase balance, and power factor.
6. Four-dial clock register.
7. Integral demand indicator.
8. Contact devices to operate remote impulse-totalizing demand meter.
9. Ratchets to prevent reverse rotation.
10. Removable meter with drawout test plug.
11. Semiflush mounted case with matching cover.
12. Appropriate multiplier tag.

H. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15-minute integrated demand of totalized system.

2.6 CONTROL POWER

- A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.
- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.7 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 switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

- C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.
- D. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.
- E. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

2.8 IDENTIFICATION

- A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
 - 1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage per manufacturer's instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.

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 concrete base.
 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 5. Install anchor bolts to elevations required for proper attachment to switchboards.
 6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.
- C. Equipment Mounting: Install switchboard on elevated platform cantilevered secured over edge of pump station wall. Conduits from service transformer entering at rear shall remain outside of the pump station building. (118th Street Only).
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
- E. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- F. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- G. Install filler plates in unused spaces of panel-mounted sections.
- H. Install overcurrent protective devices, surge protection devices, and instrumentation.
1. Set field-adjustable switches and circuit-breaker trip ranges.
- I. Install spare-fuse cabinet.
- J. Comply with NECA 1.

3.3 CONNECTIONS

- A. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.
- B. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.
- C. Support and secure conductors within the switchboard according to NFPA 70.
- D. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Test ground-fault protection of equipment for service equipment per NFPA 70.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 5. 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 switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Switchboard will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Power System Studies."

3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Electronic-grade panelboards.

1.3 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
 - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 2. 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.

2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Keys: Two spares for each type of panelboard cabinet lock.
 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 5. 1 can of touch up paint .

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD 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 to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
 - 1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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.
- E. Enclosures: Surface-mounted, dead-front 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 4X hinged door in door , 316 stainless steel (panel, trim, and backbox).
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, hinged door in door, 316 stainless steel (panel, trim, and backbox)..
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Height: 84 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
 - 4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
 - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 7. Finishes:
 - a. Panels and Trim: galvanized steel unless otherwise noted, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Same finish as panels and trim.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- F. Incoming Mains:
 - 1. Location: Convertible between top and bottom.

2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
7. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

- I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 - 1. Percentage of Future Space Capacity: 10 percent.
- K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
 - 1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 - 2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
 - 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 - 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB/GE.
 - 2. Eaton.
 - 3. Schneider Electric USA (Square D).
 - 4. Siemens Industry, Inc., Energy Management Division.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Main Circuit breaker or Lugs only as indicated on the design drawings.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB/GE.
 2. Eaton.
 3. Schneider Electric USA (Square D).
 4. Siemens Industry, Inc., Energy Management Division.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only as indicated on the design drawings.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 2. External Control-Power Source: 120-V branch circuit.
- F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- G. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.
- H. Column-Type Panelboards: Single row of overcurrent devices [**with narrow gutter extension**] [**and**] [**overhead junction box equipped with ground and neutral terminal buses**].
 1. Doors: Concealed hinges secured with multipoint latch with tumbler lock; keyed alike.

2.5 LOAD CENTERS

- A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

- B. Load Centers: Comply with UL 67.
- C. Mains: **[Circuit breaker] [or] [lugs only]**.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges secured with flush latch with tumbler lock; keyed alike.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 ELECTRONIC-GRADE PANELBOARDS

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- E. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. SPD.
 - 1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
 - 2. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V 1200 V for 208Y/120 V.
 - 3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
 - a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Neutral to Ground: 700 V.
 - d. Line to Line: 1200 V.
 - 4. SCCR: Equal to the SCCR of the panelboard in which installed.
 - 5. Inominal Rating: 20 kA.
- G. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.

2. Copper equipment and isolated ground buses.

2.7 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB/GE.
 2. Eaton.
 3. Schneider Electric USA (Square D).
 4. Siemens Industry, Inc., Energy Management Division.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - g. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Subfeed Circuit Breakers: Vertically mounted.
 9. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.

- c. UL listed for reverse connection without restrictive line or load ratings.
- d. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
- e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
- f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- g. Communication Capability: Circuit-breaker-mounted, Universal-mounted Integral, or Din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
- h. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
- j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
- k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- n. Multipole units enclosed in a single housing with a single handle.
- o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
- p. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

- 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
- 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.
 - b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
 - c. Auxiliary Contacts: **[One]** **[Two]** normally open and normally closed contact(s) that operate with switch handle operation.

2.8 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.9 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- 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. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
 - 1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
 - 3. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- G. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- H. Mount panelboard cabinet plumb and rigid without distortion of box.
- I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- K. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
 - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- M. Install filler plates in unused spaces.
- N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. 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.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
- c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Power System Studies."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Engineer. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262419 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:
 - 1. Automatic power transfer.
 - 2. Feeder-tap units.
 - 3. Measurement and control.
 - 4. Auxiliary devices.
- B. Related Requirements
 - 1. Section 260573 "Power System Studies" for arc-flash analysis and arc-flash label requirements.
 - 2. Section 260913 "Electrical Power Monitoring and Control" for power monitoring information.
 - 3. Section 262813 "Fuses" for additional information on fuses.
 - 4. Section 264313 "Surge Protection for Low-Voltage Electrical Power Cables" for SPD requirements.
 - 5. 263213 "Diesel Emergency Engine Generators" for information on interface between MCC and Diesel Generator (118th St. Only)

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCC: Motor-control center.
- C. MCCB: Molded-case circuit breaker.
- D. MCP: Motor-circuit protector.
- E. OCPD: Overcurrent protective device.
- F. PID: Control action; proportional plus integral plus derivative.
- G. PT: Potential transformer.

- H. SPD: Surge protective device.
- I. SCR: Silicon-controlled rectifier.
- J. VFC: Variable-frequency controller.
- K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.
- B. Shop Drawings: For each MCC, manufacturer's approval custom and production drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
 - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Factory-installed devices.
 - c. Enclosure types and details.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
 - f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
 - g. Specified optional features and accessories.
 - 2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
 - 3. Nameplate legends.
 - 4. Vertical and horizontal bus capacities.
 - 5. Features, characteristics, ratings, and factory settings of each installed unit.

1.5 INFORMATIONAL SUBMITTALS

- A. Standard Drawings: For each MCC, as defined in UL 845.
- B. Production Drawings: For each MCC, as defined in UL 845.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around MCCs where pipe and ducts are

prohibited. Show MCC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

- D. Qualification Data: For testing agency.
- E. Seismic Qualification Data: Certificates, for MCCs, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Product Certificates: For each MCC.
- G. Source quality-control reports.
- H. Field quality-control reports.
- I. Load-Current and Overload Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
- K. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
 - 3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 4. Manufacturer's written instructions for setting field-adjustable overload relays.
 - 5. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage, solid-state controllers.
 - 6. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - 7. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.
- D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.
- B. Handle MCCs according to the following:
 - 1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."
 - 2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
- C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; connect factory-installed space heaters to temporary electrical service.

1.10 WARRANTY

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. ABB/GE.
 - 3. Rockwell Automation, Inc.
 - 4. Schneider Electric USA (Square D).
 - 5. Siemens Industry, Inc., Energy Management Division.

2.2 SYSTEM DESCRIPTION

- A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.
- B. Ambient Environment Ratings:
 - 1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.
 - 2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
 - 3. Humidity Rating: Less than 95 percent (noncondensing).
 - 4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: MCCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 - 2. Component Importance Factor: 1.5.
 - 3. Component Amplification Factor: 2.5.
 - 4. Component Response Modification Factor: 6.0.
- B. Capacities and Characteristics:

1. MCC Enclosure and Assembly:
 - a. Nominal System Voltage: 277/480-V ac.
 - b. Service Equipment Rated: No.
 - c. Enclosure: NEMA 250, Type 1 gasketed.
2. Integrated Short-Circuit Rating for MCC:
 - a. Fully rated; with AIC as indicated on the designed drawings .
3. Integrated Short-Circuit Rating for Each Unit:
 - a. Fully rated; with AIC as indicated on the designed drawings.
4. Wiring Class: Class II.
5. Bus:
 - a. Horizontal Bus: shall match AIC rating indicated on the design drawings.
 - b. Neutral Bus: Full size.
6. Main Disconnect Device:
 - a. Main Disconnect: MCCB, UL 489, three pole, with amp rating as indicated on the design drawings. Electrically operated, electrically tripped.
 - b. SPD: UL 1449, Type 2.
 - c. Optional Features: With Profinet capable Power Monitor.
7. Automatic Power Transfer: Electrically operated MCCBs, three pole, 1200 A (118th Street) and 800 A (Wilson Boulevard) as indicated on the design drawings unless otherwise noted.
8. Magnetic Controllers:
 - a. Classification by Starting Method: Full Voltage Starters.
 - b. Controller Size: as indicated on the design drawings complying with NEMA ICS 2.
9. Controller-Mounted Auxiliary Devices:
 - a. Push Buttons and Selector Switches: Heavy-duty, oiltight type.

2.4 MOTOR CONTROL CENTER ENCLOSURES

- A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 1A unless otherwise indicated to comply with environmental conditions at installed location.
- B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 2. Space-Heater Power Source: Transformer, factory installed in MCC.

- C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

2.5 ASSEMBLY

- A. Structure:
 - 1. Comply with UL requirements for service entrance equipment.
 - 2. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
 - 3. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.
 - 4. Pull Boxes:
 - a. Include provisions for ventilation to maintain temperature in pull box within same limits as the MCC.
 - b. Set the box back from front to clear circuit-breaker removal mechanism.
 - c. Covers: Removable covers forming top, front, and sides.
 - d. Insulated bottom of fire-resistive material with separate holes for cable drops into MCC.
 - e. Cable Supports: Arranged to facilitate cabling and adequate to support cables, including supports for future cables.
 - f. When equipped with barriers, supply with access to check bus bolt tightness.
- B. Compartments: Modular; individual lift-off doors with concealed hinges and quick-captive screw fasteners.
 - 1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
 - 2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
 - 3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
- C. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.
- D. Owner's Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include PTs having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- E. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

F. Wiring Spaces:

1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

G. Provisions for Future:

1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

H. Integrated Short-Circuit Rating:

1. Short-Circuit Current Rating for Each Unit: Fully rated; 65 kA unless otherwise noted.
2. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; 65 kA unless otherwise noted.

I. Control Power:

1. 120-V ac, supplied centrally from a CPT.
2. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. CPT Spare Capacity: 50 VA.
3. Control Circuits: 24-V dc, supplied centrally from two redundant, automatically switched power supplies.
4. CPT Spare Capacity: 50 VA.

J. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

1. Wiring Class: NEMA ICS 18, Class II-S, Type B, for starters larger than Size 3 Type B-D, for starters Size 3 and smaller.
2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

K. Bus:

1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends.
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated alloy, with mechanical connectors for outgoing conductors.
4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with mechanical connectors for outgoing conductors.

5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
6. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

- A. MCCB (800 to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.
 1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.
 2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
 - a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
 - b. LED indicators or display, with manual reset, to show reasons of automatic trip.
 - c. Display panel to indicate the status of the system circuitry, or give fault location based on automatic diagnosis.
 - d. Trip the circuit breaker when closing on a fault.
 - e. Time-current adjustments to achieve protective-device coordination as follows:
 - 1) Adjustable long-delay pickup and time.
 - 2) Individual adjustments for short-delay pickup, time, and I-squared-t setting.
 - 3) Adjustable instantaneous pickup.
 - 4) Individually adjustable ground-fault pickup and time, with I-squared-t setting ground alarm.
 - f. One test kit to test each trip function.
 - g. Battery backup for informational displays after automatic trip, with battery status indicator.
 3. Switch operator power shall be from control power specified in "Assembly" Article.
- B. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type 2.

2.7 AUTOMATIC POWER TRANSFER

- A. Two-Breaker Transfer Control:
 1. Transfer control, using electrically operated MCCBs, for an MCC supplied from two normally energized low-voltage power sources, designated "normal" and "standby." The circuit breakers connecting the two power sources to the load bus shall be controlled by a microprocessor-based automatic transfer control. Power for the transfer control shall be from the voltage-sensing transformers.

2. MCCBs (to 2500 A): Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.
 - a. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.
 - b. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
 - 1) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
 - 2) Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
 - 3) Time-current adjustments to achieve protective-device coordination as follows:
 - a) Adjustable long-time delay.
 - b) Adjustable short-time setting and delay to shape the time-current curve.
 - c) Adjustable instantaneous setting.
 - d) Individually adjustable ground-fault setting and time delay.
 - 4) Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.
 - 5) Built-in digital ammeter display, showing load current and tripping cause.
3. In the automatic mode, the load bus is connected to the normal power source. When the normal source fails, the control shall automatically open the normal power source and close the standby source circuit breaker.
4. Sequence of Operation:
 - a. The default operation shall be with the normal source main breaker closed and standby main breaker open. On detection of an undervoltage to the line side of the normal main breaker and after a field-adjustable time delay, the main breaker shall open and, after an additional field-adjustable time delay, the standby breaker shall close and restore power to the facility.
 - b. On restoration of voltage to the line side of the normal main breaker and after a field-adjustable time delay, the standby main breaker shall open and, after a field-adjustable time delay, the normal main breaker shall close.
5. Field-Adjustable Transfer Parameters:
 - a. Delay the transfer from the normal power source to the standby power source and from the standby power source to the normal source. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range is zero seconds to 30 minutes.
 - b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Delay range is zero to 120 seconds.

- c. Delay the transfer from the standby power source to the normal power source. Delay range is zero seconds to 30 minutes.
 - d. A relay with contact that changes state when the power is available on the normal source, and a relay with contact that changes state when the power is available on the standby source.
- 6. Controls and Indicators: In addition to the delay setting controls, include the following:
 - a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers trip due to overcurrent or ground-fault.
 - b. Three-position selector switch to select the normal source: Source 1, Source 2, or none.
 - c. Transfer-control automatic and manual selector.
 - 1) Interlock shall prevent paralleling of the two power sources in manual mode.
 - d. Open-close control switch for manual electrical operation of each controlled circuit breaker.
 - e. Selector to place control into programming mode.
 - f. Circuit breaker control switch for each of the normal and standby source breakers, providing open and close operation.
 - g. Push button to initiate manual retransfer to the normal source when the transfer controller is in the automatic mode.
 - h. Meters and display to show the following:
 - 1) Voltage and frequency of both sources.
 - 2) A multiline display showing the following:
 - a) Set points of timers, and voltage pickup and dropout set points.
 - b) Date, time, and reason for minimum of the last 10 transfers. The display may show the information for one transfer at a time using a scrolling control, with the others held in memory.
 - c) When the control system is in the transferring process, the display shall show delay countdown in seconds.
 - i. LED indicators to show the following:
 - 1) Normal source available.
 - 2) Standby source available.
 - 3) Normal source connected.
 - 4) Standby source connected.
 - 5) Load bus energized.
- 7. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
- 8. Voltage Sensing Relays: Microprocessor-based, IEEE device number 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

2.8 MAGNETIC CONTROLLERS

- A. Controller Units: Combination controllers.
- B. Disconnects:
 - 1. MCP:
 - a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. NC alarm contact that operates only when MCP has tripped.
 - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
 - 2. MCCB:
 - a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
 - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
 - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
 - e. NC alarm contact that operates only when MCCB has tripped.
- C. Controllers: Comply with UL 508.
 - 1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.
 - a. Classification: Nonreversing and reversing.
 - 2. Multispeed Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.
 - a. Classification: Nonreversing; **[consequent pole] [two winding]**.
 - 1) Two-speed, with compelling relays to ensure that motor will start only at low speed.
 - 2) Timer Relays: Accelerating, for properly timed acceleration through speeds lower than that selected.
 - 3) Timer Relays: Decelerating, for automatically timed deceleration through each speed.
 - b. Classification: Reversing; **[consequent pole] [two winding]**.
 - 1) Two-speed, with compelling relay to ensure that motor will start only at low speed.
 - c. Timer Relays: Accelerating, for properly timed acceleration through speeds lower than that selected.

- d. Timer Relays: Decelerating, for automatically timed deceleration through each speed.
- e. Antiplugging Relays: Time delay when transferring from FORWARD to REVERSE and back.

D. Overload Relays:

1. Melting-Alloy Overload Relays:

- a. Inverse-time-current characteristic.
- b. [Class 10] [Class 20] [Class 30] tripping characteristic.
- c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

2. Bimetallic Overload Relays:

- a. Inverse-time-current characteristic.
- b. [Class 10] [Class 20] [Class 30] tripping characteristic.
- c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
- d. Ambient compensated.
- e. Automatic resetting.

3. Solid-State Overload Relays:

- a. Switch or dial selectable for motor-running overload protection.
- b. Sensors in each phase.
- c. [Class 10] [Class 20] [Class 10/20 selectable] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- e. Analog communication module.

- 4. [NC] [NO] isolated overload alarm contact.
- 5. External overload reset push button.

2.9 HARMONIC CORRECTION UNIT

- A. Harmonic Correction Unit: Provide a microprocessor-controlled power electronic device consisting of semiconductors switched into the AC lines with a modulated output to cancel detrimental harmonic and/or reactive currents. A DC bus shall store power for power semiconductor switching. Harmonic cancellation shall be applied to the entire MCC distribution bus load..

- 1. Current Limit: 100% of rating to protect semiconductors.
- 2. Input Power Circuit Breaker: Rated 100 KAIC.
- 3. Displacement power factor correction: correct to .90 lagging displacement power factor.
- 4. Current transformers: Provide 400 Hz rated CT's 2 per phase located in the MCC as indicated on the drawings..

5. Where multiple harmonic correction units are used they shall communicated with each other as required for successful implementation of harmonic mitigation.
6. Operating Interface: panel door mounted, digital device to display operating data in alphanumeric format including line voltage, total RMS load current, harmonic current of load, output harmonic and reactive current of power correction system, fault conditions, and diagnostic information. Provide run, stop, setup, enter, and up/down scroll keys.
7. Output Contacts: provide one form C relay contact, rated 5 amperes at 120V, for remote indication of power-on, run, fault and at-maximum capacity conditions.

B. Operating Modes:

1. The harmonic correction unit shall automatically inject harmonic current to cancel load produced harmonic content such that the upstream power harmonic current and voltage are reduced to below 5% TDD and 5% THD (V) as defined by ANSI IEEE standard 519-1992 for load demand and voltage distortion limits. The logic of the harmonic correction unit shall monitor the load current CT's to direct the function of the power electronic converter.
2. Reactive current compensation (displacement power factor correction) shall be activated via a digital keypad/display mounted on the door of the enclosure. When reactive current compensation is activated, the harmonic correction unit shall first perform harmonic current correction and then use the remaining capacity to inject reactive current compensation. Leading power factor is not permitted.
3. Each unit shall be designed with a current limiting function to protect the semiconductors. When this level is attained, a message shall be displayed indicating the output capacity is at-maximum capacity and actuate the at-maximum capacity relay. Operation shall continue indefinitely at this level without trip off or destruction of the power correction unit.
4. Two distinct levels of faults shall be employed. Non-critical level faults shall provide automatic restart and a return to normal operation upon automatic fault clearance. Critical level faults stop the function of the unit and await operator action.
 - a. Faults such as ac line over-voltage, AC line under-voltage, AC line power loss, and AC line phase imbalance shall be automatically restarted. Upon removal of these fault conditions, the power correction system shall restart without user action. Automatic restart will not occur if 5 faults have occurred in less than 5 minutes. During the fault condition, except line loss, the display shall state the type of fault and indicate that automatic restart will occur. The run relay and run LED shall be disabled. The fault relay shall not be enabled unless time out occurs. Upon AC line loss, the power-on relay shall be disabled and no display shall be provided.
 - b. All other types of faults shall be considered critical and stop the power correction system. The display shall indicate the fault condition and "STOP." The run indicator and relay shall be disabled and the fault relay enabled. User shall be required to initiate a power reset (turn power OFF and ON) to restart the power correction system.
 - c. When generator is in operation power correction system shall function unless a critical fault affecting system whereby the harmonic correction unit may damage equipment and other system components connected to the distribution system is present.

2.10 CONTROLLER-MOUNTED AUXILIARY DEVICES

- A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.
 - 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
 - a. Push Buttons: Unguarded types; maintained contact unless otherwise indicated.
 - b. Pilot Lights: LED types; Colors as approved by engineer. Red – running, Green – Stopped.
 - c. Selector Switches: Rotary type.
- B. Elapsed-Time Meters: Heavy duty with digital readout in hours; nonresettable.
- C. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having an off position.
- D. Auxiliary Dry Contacts: NO.
- E. Control Relays:
 - 1. Time Delay: Auxiliary and adjustable solid-state time-delay relays.
 - 2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.

2.11 MEASUREMENT AND CONTROL DEVICES

- A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
 - 1. PTs: IEEE C57.13; 120 V, 60 Hz, tapped double secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; double secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
 - 3. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
 - 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, for selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker and ground-fault protection.
- B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - 1. Refer to Electrical Power Monitoring and Control specification for requirements including by not limited to communications requirements.
 - 2. Listed or recognized by a nationally recognized testing laboratory.
 - 3. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.

4. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
 - e. Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 5. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- C. Ammeters, Voltmeters, and Power-Factor Meters: ANSI C39.1. 4-inch diameter or 6 inches square, flush or semiflush, with antiparallax 250-degree scale and external zero adjustment.
1. Voltmeters: Cover an expanded-scale range of nominal voltage plus 10 percent.
 2. Feeder Ammeters: 2-1/2-inch minimum size with 90- or 120-degree scale. Meter and transfer device with off position, located on overcurrent device door for feeder circuits, unless otherwise indicated.
- D. Instrument Switches: Rotary type with off position.
1. Voltmeter Switches: Permit reading of all phase-to-phase voltages and phase-to-neutral voltages where a neutral is included.
 2. Ammeter Switches: Permit reading of current in each phase and maintain current-transformer secondaries in a closed-circuit condition at all times.
- E. Watt-Hour Meters and Wattmeters:
1. Comply with ANSI C12.1.
 2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.
 3. Suitable for connection to three- and four-wire circuits.
 4. Potential indicating lamps.
 5. Adjustments for light and full load, phase balance, and power factor.
 6. Four-dial clock register.
 7. Integral demand indicator.
 8. Contact devices to operate remote impulse-totalizing demand meter.
 9. Ratchets to prevent reverse rotation.
 10. Removable meter with drawout test plug.
 11. Semiflush mounted case with matching cover.
 12. Appropriate multiplier tag.
- F. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with MCC watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording 15-minute integrated demand of totalized system.

- G. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

2.12 FEEDER TAP UNITS

- A. MCCBs (to 1200 A): Fixed mounted, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger. Comply with UL 489, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

1. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
2. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
3. Communication Capability: **[Circuit-breaker-mounted]** **[Universal-mounted]** **[Integral]** **[Din-rail-mounted]** communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
4. With built-in digital ammeter and a digital display, showing tripping cause.
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
7. Auxiliary Contacts: **[One SPDT switch]** **[Two SPDT switches]** with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
8. Alarm Switch: One **[NC]** **[NO]** contact that operates only when circuit breaker has tripped.
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic ground-fault and phase-fault trip unit; for interlocking ground-fault and phase-fault protection function as applicable.
11. Electrical Operator: Remote control for on, off, and reset operations.

- B. Fusible Switches (to 600 A): Fixed-mounted, manually operated, **[electrically tripped]**, fusible, quick-make, quick-break switch with 200-kA interrupting and short-circuit current rating when fitted with UL 248-8 Class J fuses. Comply with UL 98.

1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2. Include fuse clips and fuses.
3. Electrically tripped switches shall include the following:
 - a. Shunt trip.
 - b. Ground-fault protection, with adjustable time delay and test panel.
 - c. Single-phase protection, tripping the switch on loss of a source phase.
 - d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.

2.13 TRANSFORMERS

- A. Factory-assembled and -tested, air-cooled, two-winding, low-voltage dry-type transformers; with primary circuit breaker. Comply with NEMA ST 20.
- B. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.
- C. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- D. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- E. Energy Efficiency for Transformers Rated 15 kVA and Larger:
 1. Complying with NEMA TP 1, Class 1 efficiency levels.
 2. Tested according to NEMA TP 2.

2.14 SOURCE QUALITY CONTROL

- A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.
- B. MCCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive MCCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.
- B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in each fusible switch.
- F. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- H. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- I. Install power factor correction capacitors. Connect to the line side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents.
- J. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.
 - 1. Identify field-installed conductors, interconnecting wiring, and components.
 - 2. Install required warning signs.
 - 3. Label MCC and each cubicle with engraved nameplate.
 - 4. Label each enclosure-mounted control and pilot device.
 - 5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

- B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's PLC/RTU or Facility HVAC ATC panel as required for operation.. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 - 2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

- A. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. 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. 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.

4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.
 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.
- E. MCCs will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

3.7 STARTUP SERVICE

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

3.8 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.
- B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

- E. Program microprocessors in VFCs for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- F. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Power System Studies."

3.9 DEMONSTRATION

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

END OF SECTION 262419

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Standard-grade receptacles, 125 V, 20 A.
 - 2. USB receptacles.
 - 3. GFCI receptacles, 125 V, 20 A.
 - 4. SPD receptacles, 125 V, 20 A.
 - 5. Hazardous (classified) location receptacles.
 - 6. Twist-locking receptacles.
 - 7. Pendant cord-connector devices.
 - 8. Cord and plug sets.
 - 9. Toggle switches, 120/277 V, 20 A.
 - 10. Digital timer light switches.
 - 11. Residential devices.
 - 12. Wall-box dimmers.
 - 13. Wall plates.
 - 14. Floor service fittings.

1.3 DEFINITIONS

- A. AFCI: Arc-fault circuit interrupter.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with requirements in this Section.
- F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

H. Wall Plate Color: For plastic covers, match device color.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Wiring Devices - Arrow Hart).
 - b. Hubbell Incorporated (Wiring Device-Kellems).
 - c. Legrand North America, LLC (Pass & Seymour).
 - d. Leviton Manufacturing Co., Inc.
2. Description: Two-pole, three-wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498 and FS W-C-596.

B. Weather- and Corrosion-Resistant Receptacles, 120V, 20A <Insert drawing designation>:

1. Manufacturers: Pass & Seymour; Crouse-Hinds; Appleton.
2. Description: Two-pole, three-wire, with cover.
3. Configuration: NEMA WD 1 and WD 5, Configuration 5-20R.
4. Standards: Comply with UL 514A; NEMA FB-1.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet and Corrosive Locations" Article.

C. Corrosion-Resistant Receptacles, 120V, 20A <Insert drawing designation>:

1. Manufacturers: Hubbell, Eaton, Legrand.
2. Description: Two-pole, three-wire, and self-grounding. High visibility yellow nylon face, nickel plated brass or copper alloy power contacts.
3. Configuration: WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Corrosive Locations" Article.

2.3 GFCI RECEPTACLES, 125 V, 20 A

A. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Wiring Devices - Arrow Hart).
 - b. Hubbell Incorporated (Wiring Device-Kellems).
 - c. Legrand North America, LLC (Pass & Seymour).
 - d. Leviton Manufacturing Co., Inc.
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two-pole, three-wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-15R.
4. Type: Feed through.
5. Standards: Comply with UL 498 and UL 943 Class A.
6. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.4 SPD RECEPTACLES, 125 V, 20 A

A. Duplex SPD Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton (Wiring Devices - Arrow Hart).
 - b. Hubbell Incorporated (Wiring Device-Kellems).
 - c. Legrand North America, LLC (Pass & Seymour).
 - d. Leviton Manufacturing Co., Inc.
2. Description: Two-pole, three-wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
3. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
4. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
5. Configuration: NEMA WD 6, Configuration 5-20R.
6. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Hazardous (Classified) Locations Receptacles:

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

- a. [Eaton \(Wiring Devices - Arrow Hart\).](#)
 - b. [Emerson Electric Co. \(Automation Solutions - Appleton - EGS\).](#)
 - c. [Hubbell Incorporated \(Killark\).](#)
2. Description: Pin and sleeve receptacle with matching connector.
 3. Class I.
 - a. Division: 2.
 4. Raintight.
 5. Voltage: 480 V ac.
 6. Hertz: 60 Hz.
 7. Amperage: 20 A.
 8. Wires and Poles: Four wire, four pole.
 9. Standards: Comply with NEMA FB 11 and UL 1203.

2.6 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Receptacles, 120 V, 20 A **<Insert drawing designation>**:
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Configuration: NEMA WD 6, Configuration L5-20R.
 3. Standards: Comply with UL 498.
- B. Twist-Lock, Single Receptacles, 250 V, 20 A **<Insert drawing designation>**:
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Configuration: NEMA WD 6, Configuration L6-20R.
 3. Standards: Comply with UL 498.
- C. Twist-Lock, Single Receptacles, 277 V, 20 A **<Insert drawing designation>**:
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Configuration: NEMA WD 6, Configuration L7-20R.
 3. Standards: Comply with UL 498.
- D. Twist-Lock, Isolated-Ground, Single Receptacles, 125 V, 20 A **<Insert drawing designation>**:
 1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Grounding: Equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
 3. Configuration: NEMA WD 6, Configuration L5-20R.
 4. Standards: Comply with UL 498.

2.7 TOGGLE SWITCHES, 120/277 V, 20 A

- A. Single-Pole Switches, 120/277 V, 20 A:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Standards: Comply with UL 20 and FS W-S-896.
- B. Two-Pole Switches, 120/277 V, 20 A:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Comply with UL 20 and FS W-S-896.
- C. Three-Way Switches, 120/277 V, 20 A **<Insert drawing designation>**:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Comply with UL 20 and FS W-S-896.
- D. Four-Way Switches, 120/277 V, 20 A:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Standards: Comply with UL 20 and FS W-S-896.
- E. Pilot-Light, Single-Pole Switches: 120/277 V, 20 A **<Insert drawing designation>**:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Description: Illuminated when switch is **[on]** **[off]**.
 3. Standards: Comply with UL 20 and FS W-S-896.
- F. Lighted Single-Pole Switches, 120/277 V, 20 A **<Insert drawing designation>**:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Description: Handle illuminated when switch is **[on]** **[off]**.
 3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.
- G. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Description: Factory-supplied key in lieu of switch handle.
 3. Standards: Comply with UL 20 and FS W-S-896.
- H. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches, 120/277 V, 20 A:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Description: For use with mechanically held lighting contactors.
 3. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.
- 2.8 TIMER LIGHT SWITCH
- A. Digital Timer Light Switch **<Insert drawing designation>**:
1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
 2. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with selectable time interval in **[10]** **[20]**-minute increments.
 3. Standards: Comply with UL 20.

4. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
5. Integral relay for connection to BAS.

2.9 DIMMERS

A. Wall-Box Dimmers:

1. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
2. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
3. Control: Continuously adjustable [**slider**] [**toggle switch**] [**rotary knob**]; with single-pole or three-way switching.
4. Standards: Comply with UL 1472.
5. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
 - a. 600 W; dimmers shall require no derating when ganged with other devices. [**Illuminated when "off."**]
 - b. **<Insert wattage ratings and descriptions>.**
6. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.
7. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: [**Smooth, high-impact thermoplastic**] [**0.035-inch-thick, satin-finished, Type 302 stainless steel**] [**0.04-inch-thick, brushed brass with factory polymer finish**] [**0.05-inch-thick, anodized aluminum**] [**0.04-inch-thick steel with chrome-plated finish**].
3. Material for Unfinished Spaces: [**Galvanized steel**] [**Smooth, high-impact thermoplastic**].
4. Material for Damp Locations: [**Thermoplastic**] [**Cast aluminum**] with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant[, **die-cast aluminum**] [**thermoplastic**] with lockable cover.

D. Antimicrobial Cover Plates:

1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2. Tarnish resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 4. Connect devices to branch circuits using pigtails that are not less than in length.
 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

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.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. 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.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
 - 1. In healthcare facilities, prepare reports that comply with NFPA 99.
 - 2. Test Instruments: Use instruments that comply with UL 1436.
 - 3. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for 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 unacceptable.
 - 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. 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.
- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Motor-control centers.
 - c. Panelboards.
 - d. Switchboards.
 - e. Enclosed controllers.
 - f. Enclosed switches.

2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 3. Current-limitation curves for fuses with current-limiting characteristics.
 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
 5. Coordination charts and tables and related data.
 6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," Section 017823 "Operation and Maintenance Data," include the following:
1. Ambient temperature adjustment information.
 2. Current-limitation curves for fuses with current-limiting characteristics.
 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
 4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton (Bussmann & Edison).
 2. Littelfuse, Inc.
 3. Mersen USA.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
 4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.
 5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
 7. Type T: 250-V, zero- to 1200-A 600-V, zero- to 800-A rating, 200 kAIC, very fast acting, time delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
1. Size: Adequate for storage of spare fuses specified with [15] <Insert number> percent spare capacity minimum.
 2. Finish: Gray, baked enamel.
 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, fast acting Class RK1, fast acting Class J, fast acting Class T, fast acting.
2. Feeders: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class RK5, fast acting Class RK5, time delay Class J, fast acting Class J, time delay.
3. Motor Branch Circuits: Class RK1, time delay Class RK5, time delay Class CC, motor duty, time delay.
4. Large Motor Branch (601-4000 A): Class L, time delay.
5. Power Electronics Circuits: Class J, high speed.
6. Other Branch Circuits: Class RK1, time delay Class RK5, time delay Class J, fast acting Class J, time delay Class CC, fast acting.
7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Construction Manager.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Receptacle switches.
 - 4. Shunt trip switches.
 - 5. Molded-case circuit breakers (MCCBs).
 - 6. Molded-case switches.
 - 7. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, 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. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
 - b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 122 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 <.
 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by UL or a NRTL if approved by the Owner and/or Engineer, and marked for intended location and application.
- D. Comply with NFPA 70.

2.3 FUSIBLE 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. ABB (Electrification Products Division).
 2. Eaton.
 3. Schneider Electric USA (Square D).
 4. Siemens Industry, Inc., Energy Management Division.
- B. Type HD, Heavy Duty:
1. Single throw.
 2. Three pole.
 3. 600-V ac.
 4. 1200 A and smaller.
 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses.
 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 8. Service-Rated Switches: Labeled for use as service equipment.

2.4 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. ABB (Electrification Products Division).
 2. Eaton.
 3. Schneider Electric USA (Square D).
 4. Siemens Industry, Inc., Energy Management Division.
- B. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- C. Type HD, Heavy Duty, Three Pole, Single Throw, 600-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.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 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.
- E. Type HD, Heavy Duty, Three Pole, Double Throw, 600-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.
- F. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac 208-V ac.
 - 6. Hookstick Handle: Allows use of a hookstick to operate the handle.
 - 7. Lugs: Mechanical type, suitable for number, size, and conductor material.
 - 8. Service-Rated Switches: Labeled for use as service equipment.

2.5 SHUNT TRIP 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 (Bussmann & Edison).
 - 2. Littelfuse, Inc.
 - 3. Mersen USA.
- B. General Requirements: Comply with UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: 600-V ac, 30 A; UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power source of enough capacity to operate shunt trip, pilot, indicating and control devices.
- E. Accessories:
 - 1. Oiltight key switch for key-to-test function.

2. Oiltight red ON pilot light.
3. Isolated neutral lug; 200 percent rating.
4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
5. Form C alarm contacts that change state when switch is tripped.
6. Three-pole, double-throw, fire-safety and alarm relay; 120-V ac coil voltage.
7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.
8. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
9. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
10. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
11. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120-V ac.
12. Hookstick Handle: Allows use of a hookstick to operate the handle.
13. Lugs: Mechanical type, suitable for number, size, and conductor material.
14. Service-Rated Switches: Labeled for use as service equipment.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be gray baked enamel paint or Owner approved color and paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X 316 stainless steel or fiberglass if approved by Owner and Engineer) copper-free cast aluminum alloy (NEMA 250 Types 7, 9).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be directly operable through the front cover of the enclosure (NEMA 250 Type 1) directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R) externally operable with the operating mechanism being an integral part of the cover (NEMA 250 Types 7, 9). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X 316 stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Engineer Construction Manager Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Construction Manager's written permission.
 - 4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 4X, 316 Stainless Steel.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X 316 Stainless Steel.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 5. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7 with cover attached by Type 316 stainless steel bolts.

3.4 INSTALLATION

- 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.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

- 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:
 - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and clearances.
 - d. Verify that the unit is clean.
 - e. Operate the circuit breaker to ensure smooth operation.
 - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.

- a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
 - h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
 - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
 - e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

- f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 4. Perform the following infrared scan tests and inspections and prepare an Initial and Follow-up report:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- H. Prepare test and inspection reports.
 1. Test procedures used.
 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Power System Studies"

END OF SECTION 262816

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to JEA Water & Wastewater Standards (January 1, 2020 Edition) Section 435 as the primary specification and requirements for Variable-Frequency Motor Controllers. This document is intended to supplement, and not to supersede those requirements with the exception of the VFC manufacturers listed in this specification. VFC manufacturers shall be as listed in this document.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. Related Requirements:
 - 1. Section 262419 "Motor-Control Centers" for VFCs installed in motor-control centers.

1.3 DEFINITIONS

- A. CE: Conformance Europeene (European Compliance).
- B. CPT: Control power transformer.
- C. DDC: Direct digital control.
- D. EMI: Electromagnetic interference.
- E. LED: Light-emitting diode.
- F. NC: Normally closed.
- G. NO: Normally open.
- H. OCPD: Overcurrent protective device.
- I. PID: Control action, proportional plus integral plus derivative.
- J. RFI: Radio-frequency interference.
- K. VFC: Variable-frequency motor controller. See VFD.

- L. VFD: Variable-frequency drive. Used interchangeably with the term VFC.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFC indicated.
 - 1. Include dimensions and finishes for VFCs.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each VFC indicated.
 - 1. Include mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Include heat calculations for all heat generating equipment within the enclosure and confirmation that the enclosure ventilation is adequate for cooling in Jacksonville ambient temperatures.
 - 5. Provide a copy of the JEA Water & Wastewater Standards (January 1, 2020 Edition) Section 435 with a check mark next to all relevant paragraphs indicating confirmation that the provided VFC meets the project requirements.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Required working clearances and required area above and around VFCs.
 - 2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
 - 3. Show support locations, type of support, and weight on each support.
 - 4. Indicate field measurements.
- B. Product Certificates: For each VFC from manufacturer.
- C. Provide an electrical system harmonic study (analysis) for the entire electrical system. All design parameters listed in this Section are preliminary and shall be verified by this vendor with the power company prior to submitting the harmonic analysis for review and approval. The harmonic analysis submitted to the Engineer for review and approval shall be accompanied by a letter which certifies that the parameters (i.e. utility system symmetrical short circuit availability for each source of supply) are current and from whom they were obtained.
- D. The VFD supplier shall submit written confirmation that the motor characteristics (i.e. torque type, FLA, etc.) have been coordinated with the supplier of the driven equipment and that the VFDs being supplied are matched properly for the driven load.

- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFCs 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. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
 - b. Manufacturer's written instructions for setting field-adjustable overload relays.
 - c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 - e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
 - f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Indicating Lights: Two of each type and color installed.
 - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
 - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Danfoss Inc. (Aqua Drive) – Cannot duct out of building; must be in enclosure.
 2. Siemens Industry, Inc. (Building Technologies Division). (G120)
 3. Toshiba AS3
 4. Cutler-Hammer SVX9000

2.2 SYSTEM DESCRIPTION

- A. General Requirements for VFCs:
 1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A and UL 508C.
- B. Application: variable torque.
- C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
 2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
 3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
 2. Input AC Voltage Unbalance: Not exceeding 5 percent.
 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
 6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
 7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
 8. Humidity Rating: Less than 95 percent (noncondensing).
 9. Altitude Rating: Not exceeding 3300 feet.
 10. Vibration Withstand: Comply with NEMA ICS 61800-2.
 11. Overload Capability: 1.1 times base load current continuously and 1.2 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
 12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
 13. Speed Regulation: Plus or minus 10 percent.
 14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
 15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
 2. Maximum Speed: 80 to 100 percent of maximum rpm.
 3. Acceleration: 0.1 to 999.9 seconds.
 4. Deceleration: 0.1 to 999.9 seconds.
 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
 2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
 3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
 4. Under- and overvoltage trips coordinated with VFD ride-through function.
 5. Inverter overcurrent trips.
 6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
 7. Critical frequency rejection, with three selectable, adjustable deadbands.
 8. Instantaneous line-to-line and line-to-ground overcurrent trips.
 9. Loss-of-phase protection.
 10. Reverse-phase protection.
 11. Short-circuit protection.
 12. Motor-overtemperature fault.
- K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- O. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
 2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
 3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
 4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
 5. NC alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2.4 CONTROLS AND INDICATION

- A. Controls shall, as a minimum, perform the control logic indicated on the Contract Drawings and as specified herein.
- B. Status Lights: Door-mounted LED indicators displaying the following conditions:
 1. Power on.
 2. Run.
 3. Overvoltage.
 4. Line fault.
 5. Overcurrent.
 6. External fault.
- C. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 1. Keypad: In addition to required programming and control keys, include keys for Local/Remote, Jog, FWD/Rev, Run and Stop.
- D. Historical Logging Information and Displays:
 1. Real-time clock with current time and date.
 2. Running log of total power versus time.
 3. Total run time.
 4. Fault log, maintaining last four faults with time and date stamp for each.
- E. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
 1. Output frequency (Hz).
 2. Motor speed (rpm).
 3. Motor status (running, stop, fault).
 4. Motor current (amperes).
 5. Motor torque (percent).
 6. Fault or alarming status (code).
 7. PID feedback signal (percent).
 8. DC-link voltage (V dc).
 9. Set point frequency (Hz).
 10. Motor output voltage (V ac).
- F. Control Signal Interfaces:
 1. Electric Input Signal Interface:

- a. A minimum of two programmable analog inputs: 0- to 10-V dc and 4- to 20-mA dc.
 - b. A minimum of six multifunction programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
 - a. 0- to 10-V dc.
 - b. 4- to 20-mA dc.
 - c. Potentiometer using up/down digital inputs.
 - d. Fixed frequencies using digital inputs.
3. Output Signal Interface: A minimum of one programmable analog output signal(s) (via profinet, which can be configured for any of the following:
 - a. Output frequency (Hz).
 - b. Output current (load).
 - c. DC-link voltage (V dc).
 - d. Motor torque (percent).
 - e. Motor speed (rpm).
 - f. Set point frequency (Hz).
4. Remote Indication Interface: A minimum of four programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - a. Motor running.
 - b. Set point speed reached.
 - c. Fault and warning indication (overtemperature or overcurrent).
 - d. PID high- or low-speed limits reached.

G. Interface with PLC/RTU:

1. Each drive shall come with a Profinet module that supports “Profidrive” communications not just profinet. Each drive must support profinet as a native protocol; a protocol translator between drives isn’t acceptable.

2.5 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.
- B. Output Filtering: VFC’s shall have a DV/DT output filter on each drive.
- C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 OPTIONAL FEATURES

- A. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.
- B. VFD Cabinet Space Heater inside of Enclosure: Preheats motor when idle to prevent moisture accumulation in the motor.
- C. Power loss ride-through function: For a period of time upon power loss drive shall maintain control power and be able to catch a spinning motor upon restoration of normal power.
 - 1.
- D. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- E. Remote digital operator kit.
- F. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer.

2.7 ENCLOSURES

- A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 12.

2.8 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
 - 1. Push Buttons: Unguarded.
 - 2. Pilot Lights: Push to test.
 - 3. Selector Switches: Rotary type.
 - 4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
 - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- D. Supplemental Digital Meters:
 - 1. Elapsed-time meter.

2. Kilowatt meter.
 3. Kilowatt-hour meter.
- E. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with **[composite] [stainless-steel]** **<Insert material>** intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.
- H. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- I. Spare control-wiring terminal blocks; wired.

2.9 ADDITIONAL CONSTRUCTION REQUIREMENTS

- A. Disconnect handle height shall not exceed NEC requirements with VFC is located on 4-inch high housekeeping pad.
- B. VFC's shall utilize 115 VAC control power for operator devices, cooling fans, motor space heaters and external control circuits. Control power transformer shall be fused on the primary and secondary. Control circuits shall be isolated from power circuits.
- C. VFC shall include a copper ground bus.
- D. All bus and exposed copper shall be tin plated.
- E. All floor mounted enclosures shall have complete 18" (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All wall mounted enclosures shall have complete 12" (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.
- F. A switchable fluorescent light shall be provided within each floor mounted section of the enclosure.
- G. Barriers shall be provided on terminals that remain energized with the power disconnect OFF.
- H. All circuit boards shall be conformal coated to help protect them from hydrogen sulfide gases.
- I. Identification
1. All wiring shall be numbered at each end with typed sleeve type labels at each termination. Labels shall correspond to the wiring diagrams. Wiring less than 6 inches may be numbered at only one end.
 2. Provide warning signs on terminals that are energized with the power disconnect OFF.

3. Provide 2-inch by 5-inch, nominal, engraved three-layer laminated plastic master nameplates on each VFD fastened with stainless steel screws or rivets. Nameplates shall be black letters with white background core, 3/8-inch high lettering and shall indicate equipment designation as shown on the Drawings.
4. Provide legend plates or 1-inch by 3-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.
5. Provide permanent warning signs as follows:
 - a. "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.
 - b. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT".

2.10 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
 1. Test each VFC while connected to its specified motor or a motor that is comparable to that for which the VFC is rated.
 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by

bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

- B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
 - 1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
 - 2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."
- D. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- F. Install fuses in each fusible-switch VFC.
- G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.
- I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- J. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

- A. Install wiring between VFCs and remote devices and PLC/RTU. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

- A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each VFC with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 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. Acceptance Testing Preparation:
 1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- E. Tests and Inspections:
 1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
 3. Test continuity of each circuit.
 4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
 5. Test each motor for proper phase rotation.
 6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. VFCs will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Field test all the hardwired discrete and analog connections and any software communication (Profinet) that are connect to remote control equipment when the VFC is placed in remote. The manufacturer shall at a minimum verify with the proper testing equipment that the following can be achieved:
 - a. The drive can be started and stopped remotely
 - b. The drive can have its speed changed remotely
 - c. The remote equipment can read the VFC discrete status information.
 - d. The remote equipment can read the VFC speed feedback information.
 3. Refer to JEA Water & Wastewater Standards for startup procedures

3.7 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Power System Studies."
- F. Set field-adjustable pressure switches.

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

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

3.10 CLEANING

- A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.
- B. Replace all cabinet ventilation filters upon commencement of the Contract warranty period.

END OF SECTION 262923

SECTION 263213.13 - DIESEL EMERGENCY ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to JEA Facility Standards Section 26 32 13 – Engine Generator Diesel, as the primary specification and requirements for engine generator set, enclosure, and appurtenance requirement. This document is intended to supplement, and not to supersede those requirements.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes packaged diesel engine generators for emergency use with the following features:
 - 1. Diesel engine.
 - 2. Diesel fuel-oil system.
 - 3. Control and monitoring.
 - 4. Generator overcurrent and fault protection.
 - 5. Generator, exciter, and voltage regulator.
 - 6. Outdoor engine generator enclosure.
 - 7. Vibration isolation devices.
 - 8. Finishes.
- B. Related Requirements:
 - 1. Section 263600 "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 DEFINITIONS

- A. EPS: Emergency power supply.
- B. EPSS: Emergency power supply system.
- C. 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.

1.4 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 gallons 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 airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating 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. Indicate access requirements affected by height of subbase fuel tank.
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 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.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer manufacturer and testing agency.

B. 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.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control reports.

D. Warranty: For special warranty.

1.6 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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1.8 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.

1.9 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

2.1 PERFORMANCE REQUIREMENTS

- A. B11 Compliance: Comply with B11.19.
- B. NFPA Compliance:

1. Comply with NFPA 37.
 2. Comply with NFPA 70.
 3. Comply with NFPA 110 requirements for Level 1 EPSS.
- C. UL Compliance: Comply with UL 2200.
- D. Engine Exhaust Emissions: Comply with EPA Tier 2 or 3 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.
- F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: 5 to 104 deg F.
 2. Relative Humidity: Zero to 95 percent.
 3. Altitude: Sea level to 1000 feet.
- G. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:
1. VFC loads with harmonic filters limiting THD to less than 5%.

2.2 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 qualified testing agency, and marked for intended location and application.
- C. EPSS Class: Engine generator shall be classified as a Class 120 according to NFPA 110.
- D. Service Load: 500 kVA (118th Street), 450 kVA (Wilson Blvd)
- E. Power Factor: 0.8, lagging.
- F. Frequency: 60 Hz
- G. Voltage: 277/480V V ac.
- H. Phase: Three-phase, four-wire wye.
- I. Induction Method: Turbocharged.
- J. Governor: Adjustable isochronous, with speed sensing.

- K. 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 engine generator center of gravity.
- L. 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, with capacity as required to operate as a unit as evidenced by records of prototype testing.
 - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- M. 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: Comply with NFPA 110, Type 10 system requirements.
- N. Engine Generator Performance for Sensitive Loads:
 - 1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
 - a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
 - 2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage, from no load to full load.

3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency, from no load to full load.
5. 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.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content, measured line to neutral, shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
 - a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.3 DIESEL ENGINE

- A. Fuel: ASTM D 975 diesel fuel oil, Grade 2-D S15.
- 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.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and with UL 499.
- 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.
 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- F. 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 from exhaust discharge after installation is complete shall be 70 dBA or less.
- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 24 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.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times 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 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.
 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 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 to 140 deg F 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.
- d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
- 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 1 wall-mounted cabinet.

2.4 DIESEL FUEL-OIL SYSTEM

- A. Comply with NFPA 30.
- B. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.
- C. Fuel Filtering: Remove water and contaminants larger than 1 micron.
- D. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- E. Fuel-Oil Storage Tank: Comply with requirements in Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks".
 1. Fuel Tank Capacity: Fuel for the hours of continuous operation required for the indicated EPSS Class.
 2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."
- F. Day Tank (Wilson Boulevard Only): Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
 1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.
 - a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
 2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of four hours' operation at 100 percent of rated power output of engine generator system without being refilled.

3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel-supply pump at 110 percent of rated capacity, including fuel returned from engine.
 4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
 5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel-shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
 6. Piping Connections: Factory-installed fuel-supply and return lines, from tank to engine; local fuel fill; vent line; overflow line; and tank drain line with shutoff valve.
 7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.
- G. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 2085 fuel-oil tank. Features include the following:
1. Tank level indicator.
 2. Fuel-Tank Capacity: Fuel for the hours of continuous operation for indicated EPSS class.
 3. Leak detection in interstitial space.
 4. Vandal-resistant fill cap.
 5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 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.
- C. 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 engine generator 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 engine generator 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.
- D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
1. Indicate ground fault with other engine generator alarm indications.
 2. Trip generator protective device on ground fault.

2.6 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. Range: Provide broad range of output voltage by adjusting the excitation level.
- E. 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.
- F. Enclosure: Dripproof.
- G. Instrument Transformers: Mounted within generator enclosure.
- H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
 2. Provide anti-hunt provision to stabilize voltage.
 3. Stabilize frequency at rated frequency within two seconds.
- I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- K. Subtransient Reactance: 12 percent, maximum.

2.7 OUTDOOR ENGINE GENERATOR ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph. 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: <Insert level>.
- 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 of up to 100 mph.
- D. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."
- E. Hinged Doors: With padlocking provisions.
- F. Space Heater: Thermostatically controlled and sized to prevent condensation.
- 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 two 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 luminaires 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.
- K. Convenience Outlets: Factory-wired GFCI. Arrange for external electrical connection.

2.8 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Bridge-bearing neoprene, complying with AASHTO M 251 separated by steel shims.
 2. Shore A Scale Durometer Rating: 60.
 3. Number of Layers: Three.
 4. Minimum Deflection: 1 inch.
- B. 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- 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.
- C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.
- D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.
- E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.9 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 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.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.
- 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.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in 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.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- C. Equipment Mounting:
 1. 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."
 2. 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.
 3. Install packaged engine generator and/or engine generator in a walk-in enclosure with elastomeric isolator pads and restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets and enclosure to anchor bolts installed in concrete bases
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.
- C. Connect cooling-system water piping to engine generator and with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
 - 1. Additional requirements for diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."
- 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.

3.4 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.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and in "Visual and Mechanical Inspection" and "Electrical and Mechanical Tests" 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 the Specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify that the unit is clean.
- b. Electrical and Mechanical Tests:
 - 1) Perform insulation-resistance tests according to IEEE 43.
 - a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
 - b) Machines 200 hp 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) Conduct performance test according to NFPA 110.
 - 7) Verify correct functioning of the governor and regulator.
2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding . 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 engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- D. Coordinate tests with tests for transfer switches, and run them concurrently.
- E. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
- K. 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.
- L. 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.

3.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and 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. Parts shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

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

END OF SECTION 263213.13

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes automatic transfer switches rated 600 V and less, including the following:
 - 1. Bypass/isolation switches.
 - 2. Remote annunciator and control system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.
 - 3. 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.
 - 4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer-authorized service representative.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product 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. Features and operating sequences, both automatic and manual.
 - b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications:
 - 1. Member company of NETA.
 - a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 110.
- D. Comply with UL 1008 unless requirements of these Specifications are stricter.
- E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

Table II. ASCO UL1008 Withstand and Closing Ratings ^{1,2,7}
(RMS Symmetrical Amps)

Frame	Switch Rating (Amps)		300, 4000 & 7000 Series				4000 & 7000 Series			7000 Series												
			Current Limiting Fuses				Specific Breaker			Time Based				Short Time Ratings ³ (sec)								
	Transfer Switches	Bypass Switches	480V Max.	600V Max.	Max Size, A	Class	240V Max.	480V Max.	600V Max.	Time (sec)	240V Max.	480V Max.	600V Max.	480V Max.				600V Max.				
			.13	.2	.3	.5	.1	.13	.3	.5												
D	30	-	100kA	-	300	J	22kA	22kA	10kA	0.025	10kA	10kA	10kA	-				-				
			200kA	35kA	200	J																
			35kA	35kA	200	RK1																
D	70, 100	-	200kA	35kA	200	J	150kA	85kA	25kA	0.025	10kA	10kA	10kA	-				-				
			35kA	35kA	200	RK1																
			200kA	35kA	200	J																
D	150	-	200kA	35kA	200	J	150kA	85kA	25kA	0.025	10kA	10kA	10kA	-				-				
			200kA	-	200	J	200kA	85kA	14kA	0.025	10kA	10kA	10kA	-				-				
D	200	-	100kA	-	300	J	200kA	85kA	14kA	0.025	10kA	10kA	-	-				-				
D	230	-	100kA	-	300	J	200kA	85kA	14kA	0.025	10kA	10kA	-	-				-				
E	260, 400	-	200kA	-	600	J	65kA	42kA	35kA	0.05	35kA	35kA	22kA	-				-				
			200kA	-	600	J	65kA	42kA	35kA	0.05	35kA	35kA	22kA	-				-				
J	150, 200, 260	150, 200, 230, 260	200kA	200kA	600	J	200kA	200kA	42kA	0.05	65kA	42kA ⁵	35kA	7.5kA	-		-		-			
			800		600	L	200kA	200kA	42kA	0.05	65kA	42kA ⁵	35kA	7.5kA	-		-		-			
J	400	400	200kA	200kA	600	J	65kA	50kA	42kA	0.05	65kA	42kA ⁵	35kA	7.5kA	-		-		-			
			800		600	L	65kA	50kA	42kA	0.05	65kA	42kA ⁵	35kA	7.5kA ⁶	-		-		-			
J	600	600	200kA	200kA	800	L	65kA	50kA	42kA	0.05	65kA	42kA ⁵	35kA	7.5kA ⁶	-		-		-			
			200kA	200kA	600	J																
H ⁴	600	600	200kA	200kA	1600	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA	-		36kA		-			
P ⁴	600	600	200kA	200kA	1600	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA	30kA	36kA		-				
P ⁴	800	800 - 1200	200kA	200kA	1600	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA	30kA	36kA		-				
H	800 - 1200	800 - 1200	200kA	200kA	1600 ⁴	L	65kA	65kA	65kA	0.05	50kA	50kA	50kA	36kA	-		36kA		-			
Q ⁵	600-1600	600-1600	200kA	200kA	2000	L	65kA	65kA	65kA	0.05	65kA	65kA	65kA	50kA				50kA				
S ⁶	800 - 1200	800 - 1200	200kA	200kA	2500	L	100kA	100kA	65kA	0.05	100kA	100kA	65kA	65kA				65kA				
G ⁵	1000 - 1200	1000 - 1200	200kA	200kA	2000	L	85kA	85kA	85kA	0.05	85kA	85kA	85kA	-				-				
G	1600 - 2000 (Front Connected TS Only)	1600 - 2000	200kA	200kA	2500	L	85kA	85kA	85kA	0.05	85kA	85kA	85kA	42kA	36kA		-					
G ⁵	1600 - 2000	1600 - 2000	200kA	200kA	3000	L	125kA ⁶	125kA ⁶	100kA	0.05	100kA	100kA	100kA	42kA	36kA	42kA		-				
S ⁶	1600 - 2000	1600 - 2000	200kA	200kA	2500	L	100kA	100kA	85kA	0.05	100kA	100kA	85kA	85kA	65kA	85kA		65kA				
G	2600 - 3000	2600 - 3000	200kA	200kA	4000	L	100kA	100kA	100kA	0.05	100kA	100kA	100kA	42kA	36kA	42kA		-				
G ⁵	3200	-	200kA	-	4000	L	100kA	100kA	-	0.05	100kA	100kA	-	-				-				
G	4000	4000	200kA	200kA	5000	L	100kA	100kA	100kA	0.05	100kA	100kA	100kA	85kA	65kA	65kA		85kA				
U ⁵	2600 - 4000	2600 - 4000	200kA	200kA	5000	L	125kA	125kA	125kA	0.05	125kA	125kA	125kA	100kA	100kA				100kA			

Notes: 1) All WCR values indicated are tested in accordance with the requirements of UL 1008, 7th Edition. See ASCO Pub. 1128 for more WCR information.
2) Application requirements may permit higher WCR for certain switch sizes.
3) Short Time ratings are provided for applications involving circuit breakers that utilize trip delay settings for system selective coordination.
4) Max fuse rating is 1200A on front connected H frame switches.
5) Switches utilizing overlapping neutral (code "C") have 35kA, 0.050 Sec time based rating at 480V Max.
6) Rating shown is for Bypass switches only, Transfer Switch rating is 100kA.
7) See ASCO for Service Entrance Switch ratings.

1. Short-time withstand capability for 0.5 seconds.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

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

1. ASCO/Square D 7000 series.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Tin-plated copper. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
 3. Conductor Connectors: Suitable for use with conductor material and sizes.
 4. Material: Tin-plated Hard-drawn copper, 98 percent conductivity.
 5. Main and Neutral Lugs: Compression type.
 6. Ground Lugs and Bus-Configured Terminators: Compression type.
 7. Ground bar.
 8. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
 2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
 3. Fully automatic break-before-make operation with center off position.
 4. Failure of power source serving load initiates automatic break-before-make transfer.
- E. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- F. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
- G. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- H. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.
 2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 5. Test Switch: Simulate normal-source failure.
 6. Switch-Position Pilot Lights: Indicate source to which load is connected.
 7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

- a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Four normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.

I. Large-Motor-Load Power Transfer:

1. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
2. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the

following features for each combined automatic transfer switch and bypass/isolation switch:

- a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
 - b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
 - c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
 - d. Transition: Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
 - e. Transition: Provide open-transition operation when transferring between power sources.
 - f. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
 - g. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
 - h. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
 - i. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.
 - j. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
 - k. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.
4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed tin-plated copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:
 - a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
 - b. Indication of switch position.
 - c. Indication of switch in test mode.
 - d. Indication of failure of digital communication link.
 - e. Key-switch or user-code access to control functions of panel.
 - f. Control of switch-test initiation.
 - g. Control of switch operation in either direction.
3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication

link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

4. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
 - a. Controls and indicating lights grouped together for each transfer switch.
 - b. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
 - c. Digital Communication Capability: Matched to that of transfer switches supervised.
 - d. Mounting: Flush, modular, steel cabinet unless otherwise indicated.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.
- B. Prepare test and inspection reports.
 1. For each of the tests required by UL 1008, performed on representative devices, for optional standby systems. Include results of test for the following conditions:
 - a. Overvoltage.
 - b. Undervoltage.
 - c. Loss of supply voltage.
 - d. Reduction of supply voltage.
 - e. Alternative supply voltage or frequency is at minimum acceptable values.
 - f. Temperature rise.
 - g. Dielectric voltage-withstand; before and after short-circuit test.
 - h. Overload.
 - i. Contact opening.
 - j. Endurance.
 - k. Short circuit.
 - l. Short-time current capability.
 - m. Receptacle withstand capability.
 - n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." (Wilson Boulevard Only)
 2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 3. Provide workspace and clearances required by NFPA 70.
- B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
- C. Identify components according to Section 260553 "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. Comply with NECA 1.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, PLC/RTU 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. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."
- G. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.
- H. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."
- I. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.
 - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
 - 3. Electrical Tests:
 - a. Perform insulation-resistance tests on all control wiring with respect to ground.
 - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
 - c. Verify settings and operation of control devices.
 - d. Calibrate and set all relays and timers.
 - e. Verify phase rotation, phasing, and synchronized operation.
 - f. Perform automatic transfer tests.
 - g. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.

- 2) Engine start sequence.
 - 3) Time delay on transfer.
 - 4) Alternative source voltage-sensing and frequency-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer on normal power restoration.
 - 8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and 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 retransfer from 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 one pole deviating by more than 50 percent from other poles.
 - g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- C. Coordinate tests with tests of generator and run them concurrently.
 - D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - E. Transfer switches will be considered defective if they do not pass tests and inspections.

- F. Remove and replace malfunctioning units and retest as specified above.
- G. Prepare test and inspection reports.
- H. 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. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes lightning protection system for ordinary structures.
- B. Section includes lightning protection system for the following:
 - 1. Pump Station Buildings and Structures (118th St. and Wilson Blvd).
 - 2. Light poles (118th St. and Wilson Blvd.).
 - 3. Generator Enclosure (118th St. Only)

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
 - 2. Include raceway locations needed for the installation of conductors.
 - 3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
 - 4. Include roof attachment details, coordinated with roof installation.
 - 5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Lightning protection cabling attachments to roofing systems and accessories.
 - 2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
 - 3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.
- B. Qualification Data: For Installer.

- C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.
- D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For lightning protection system to include in maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
 - b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.
- B. Completion Certificate:
 - 1. UL Master Label Certificate and LPI Master Certificate.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: UL-listed installer, category OWAY and LPI Master Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. East Coast Lightning Equipment Inc.
 - 2. Harger Lightning & Grounding.
 - 3. nVent (ERICO).
 - 4. Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.
- B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.
- C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. Copper unless otherwise required or approved by the engineer.
2. 5/8-inch diameter by 18 inches long.
3. Rounded tip.
4. Threaded base support.

B. Air Terminal Bracing:

1. Copper.
2. **5/8-inch** diameter rod.

C. Class I Main Conductors:

1. Tinned Copper: 57,400 circular mils in diameter.

D. Class II Main Conductors:

1. Tinned Copper: 115,000 circular mils in diameter.

E. Secondary Conductors:

1. Tinned Copper: 26,240 circular mils in diameter.

F. Ground Loop Conductor: Tinned copper.

G. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 5/8 inch.
3. Rods shall be not less than 120 inches long.

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.
- C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

- A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.
- B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors or exothermic weld.
- 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 bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 1. Perform inspections as required to obtain a UL Master Label for system.
 2. Perform inspections to obtain an LPI certification.
- B. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Type 1 surge protective devices.
 - 2. Type 2 surge protective devices.
 - 3. Enclosures.
 - 4. Conductors and cables.
- B. Related Requirements:
 - 1. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.
 - 2. Section 262416 "Panelboards" for integral SPDs installed by panelboard manufacturer.
 - 3. Section 262419 "Motor Control Centers" for integral SPD's installed by MCC manufacturer.
 - 4. Section 262726 "Wiring Devices" for integral SPDs installed by receptacle manufacturer.

1.3 DEFINITIONS

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. Mode(s), also Modes of Protection: Air of electrical connections where the VPR applies.
- D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- E. NRTL: Nationally recognized testing laboratory.
- F. OCPD: Overcurrent protective device.
- G. SCCR: Short-circuit current rating.
- H. SPD: Surge protective device.

- I. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- J. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- K. Type 3 SPDs: Point of utilization SPDs.
- L. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.
- M. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.
- N. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include electrical characteristics, specialties, and accessories for SPDs.
 - 2. NRTL certification of compliance with UL 1449.
 - a. Tested values for VPRs.
 - b. Inominal ratings.
 - c. MCOV type designations.
 - d. OCPD requirements.
 - e. Manufacturer's model number.
 - f. System voltage.
 - g. Modes of protection.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TYPE 1 SURGE PROTECTIVE DEVICES (SPDs)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advanced Protection Technologies Inc. (APT).
 2. Eaton.
 3. LEA.
 4. Liebert; a brand of Vertiv.
 5. Schneider Electric USA, Inc.
 6. Siemens Industry, Inc., Energy Management Division.
- B. Source Limitations: Obtain devices from single source from single manufacturer.
- C. Standards:
1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1.
- D. Product Options:
1. Include integral disconnect switch.
 2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Include indicator light display for protection status.
 4. Include audible alarm.
 5. Include NEMA ICS 5, dry Form C contacts rated at 2 A and 24 V ac **<Insert values>**, for remote monitoring of protection status.
 6. Include surge counter.
- E. Performance Criteria:
1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
 2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 200 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
 3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
 - b. Line to Line: 2000 V for 480Y/277 V 1200 V for 208Y/120 V.
 4. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must not exceed the following:
 - a. Line to Neutral: 700 V.

- b. Line to Line: 1200 V.
- 5. SCCR: Not less than 200 kA.
- 6. Inominal Rating: 20 kA.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advanced Protection Technologies Inc. (APT).
 - 2. Eaton.
 - 3. Liebert; a brand of Vertiv.
 - 4. Schneider Electric USA, Inc.
 - 5. Siemens Industry, Inc., Energy Management Division.
- B. Source Limitations: Obtain devices from single source from single manufacturer.
- C. Standards:
 - 1. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.
 - 2. Comply with UL 1283.
- D. Product Options:
 - 1. Include LED indicator lights for power and protection status.
 - 2. Include internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - 3. Include NEMA ICS 5, dry Form C contacts rated at 2A and 24 V ac, for remote monitoring of protection status.
 - 4. Include surge counter.
- E. Performance Criteria:
 - 1. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
 - 2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 150 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
 - 3. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V 208Y/120 V, three-phase, four-wire circuits must not exceed the following:
 - a. Line to Neutral: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
 - b. Line to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
 - c. Neutral to Ground: 1200 V for 480Y/277 V 700 V for 208Y/120 V.
 - d. Line to Line: 2000 V for 480Y/277 V 1200 V for 208Y/120 V
 - 4. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits must not exceed the following:

- a. Line to Neutral: 700 V.
 - b. Line to Ground: 700 V.
 - c. Neutral to Ground: 700 V.
 - d. Line to Line: 1200 V.
5. SCCR: Equal or exceed 200 kA.
6. Inominal Rating: 20 kA.

2.3 TYPE 3, TYPE 4, AND TYPE 5 SURGE PROTECTIVE DEVICES (SPDs)

- A. Type 3, Type 4, and Type 5 SPDs are not approved for field installation.[See "Related Requirements" Paragraph in "Summary" Article for products with manufacturer-installed Type 3, Type 4, and Type 5 SPDs.]

2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 4X.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's written instructions.
- C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's written instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- 1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
 - 2. Do not exceed manufacturer's recommended lead length.
 - 3. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. SPDs that do not pass tests and inspections will be considered defective.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks in accordance with manufacturer's written instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following types of LED luminaires:
 - 1. Highbay, linear.
 - 2. Highbay, nonlinear.
 - 3. Linear industrial.
 - 4. Lowbay.
 - 5. Surface mount, linear.
 - 6. Surface mount, nonlinear.
 - 7. Suspended, linear.
 - 8. Suspended, nonlinear.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment and luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Ceiling-mounted projectors.
7. Moldings.

- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of luminaire.
- E. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

- E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Engineer's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."
- C. Ambient Temperature: 5 to 104 deg F.
 - 1. Relative Humidity: Zero to 100 percent.
- D. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE REQUIREMENTS

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

- B. Factory-Applied Labels: Comply with UL 1598. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles.
 - 1. Label shall include the following lamp characteristics:
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- F. California Title 24 compliant.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:
 - 1. ASTM A 36/A 36M for carbon structural steel.
 - 2. ASTM A 568/A 568M for sheet steel.
- C. Stainless Steel:
 - 1. 1. Manufacturer's standard grade.
 - 2. 2. Manufacturer's standard type, ASTM A 240/240 M.
- D. Galvanized Steel: ASTM A 653/A 653M.
- E. Aluminum: ASTM B 209.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- D. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.

E. Wall-Mounted Luminaires:

1. Attached to structural members in walls or Attached to a minimum 20 gauge backing plate attached to wall structural members or Attached using through bolts and backing plates on either side of wall.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaires:

1. Ceiling Mount:

- a. Two 5/32-inch- diameter aircraft cable supports adjustable to required length.
 - b. Pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to required length.
 - c. Hook mount.
2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
 5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."
- B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 1. During adjustment visits, inspect all luminaires. Replace drivers or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Engineer or Engineer

END OF SECTION 265119

SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule:
 - 1. For emergency lighting units. Use same designations indicated on Drawings.
 - 2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Luminaires.
 - 2. Suspended ceiling components.
 - 3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
 - 4. Structural members to which equipment will be attached.
 - 5. Size and location of initial access modules for acoustical tile.
 - 6. Items penetrating finished ceiling including the following:
 - a. Other luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Ceiling-mounted projectors.
 - e. Sprinklers.
 - f. Access panels.
 - 7. Moldings.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.
- C. Product Certificates: For each type of luminaire.
- D. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 4. Provide seismic qualification certificate for each piece of equipment.
- E. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.
1. Obtain Engineer's approval of luminaires and signs in mockups before starting installations.

2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Two year(s) from date of Substantial Completion.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
 2. Warranty Period for Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Luminaires and lamps shall be labeled vibration and shock resistant.
 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

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

- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast/driver.
 - 1. Emergency Connection: Operate one lamp(s) continuously at an output of as indicated on the design drawings lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet.
 - 4. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.
 - 5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Battery: Sealed, maintenance-free, nickel-cadmium or lead-acid type, as indicated on the drawings.
 - 7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Lighting Unit:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Dual-Lite.
 - b. Eaton (Lighting).
 - c. Evenlite, Inc.
 - d. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 2. Emergency Lighting Unit: E-35 as indicated on Light Fixture Schedule.
 - 3. Operating at nominal voltage of 120 V ac.
 - 4. Wall with universal junction box adaptor.
 - 5. UV stable thermoplastic housing, rated for damp locations.
 - 6. Two LED lamp heads.
 - 7. Internal emergency power unit.

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dual-Lite.
 - b. Evenlite, Inc.
 - c. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 2. Operating at nominal voltage of 120 V ac.
 - 3. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
 - 4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
 - 5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
 - 6. Master/Remote Sign Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply and battery for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Clear, UV-stabilized acrylic.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing and heat sink.
2. powder coat painted finish.

E. Conduit: Rigid aluminum conduit or Flexible metallic conduit, minimum 3/4 inch in diameter.

2.6 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls or Attached to a minimum 20-gage backing plate attached to wall structural members.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and [**tubing or rod**] [**wire support**] for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Perform startup service:
1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
1. Inspect all luminaires. Replace lamps,, batteries, signs, or luminaires that are defective.
 - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265213

SECTION 265613 - LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Poles and accessories for support of luminaires.
 - 2. Luminaire-lowering devices.

1.3 DEFINITIONS

- A. EPA: Equivalent projected area.
- B. Luminaire: Complete luminaire.
- C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.
- D. Standard: See "Pole."

1.4 ACTION SUBMITTALS

- A. Product Data: For each pole, accessory, and luminaire-supporting and -lowering device, arranged as indicated.
 - 1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
 - 2. Include finishes for lighting poles and luminaire-supporting devices.
 - 3. Anchor bolts.
 - 4. Manufactured pole foundations.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Detail fabrication and assembly of poles and pole accessories.

4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
 5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
 6. Method and procedure of pole installation. Include manufacturer's written installations.
- C. Samples: For each exposed lighting pole, standard, and luminaire-supporting device and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

- A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.
- B. Seismic Qualification Data: For luminaires, poles, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Material Test Reports:
1. For each foundation component, by a qualified testing agency.
 2. For each pole, by a qualified testing agency.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Sample Warranty: Manufacturer's standard warranty.
- G. Soil test reports

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For poles to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include pole inspection and repair procedures.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Pole repair materials.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1093 for foundation testing.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B660.
- B. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below finished grade.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) 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 a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
 - 2. Warranty Period for Corrosion Resistance: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design pole foundation and pole power system.
- B. Seismic Performance: Foundation and pole shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 2. Component Importance Factor: 1.5.
- C. Structural Characteristics: Comply with AASHTO LTS-6-M.
- D. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.
- E. Live Load: Single load of 500 lbf distributed according to AASHTO LTS-6-M.
- F. Ice Load: Load of 3 lbf/sq. ft., applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.
- G. Wind Load: Pressure of wind on pole and luminaire, calculated and applied according to AASHTO LTS-6-M.
1. Basic wind speed for calculating wind load for poles 50 feet high or less is as indicated on the structural S-1 drawings sheet.
 - a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 25 years.
 - c. Velocity Conversion Factor: 1.0.
- H. Strength Analysis: For each pole, multiply the actual EPA of luminaires and brackets by a factor of 1.1 to obtain the EPA to be used in pole selection strength analysis.
- I. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 ALUMINUM POLES

- A. [<Double click here to find, evaluate, and insert list of manufacturers and products.>](#)
- B. Poles: Seamless, extruded structural tube complying with ASTM B221, Alloy 6061-T6, with access handhole in pole wall.
1. Shape: Round, tapered or Round, straight.
 2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.
- C. Mast Arms: Aluminum Single-arm Truss or Davit type, continuously welded to pole attachment plate. Material and finish same as plate.
- D. Brackets for Luminaires: Detachable, cantilever, without underbrace.
1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adaptor, then bolted together with stainless-steel bolts.
 2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire. Match pole material and finish.

- E. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- F. Grounding and Bonding Lugs: Bolted 1/2-inch threaded lug, complying with requirements in Section 260526 "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.
- G. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.
 - 1. Materials: Compatible with poles and standards as well as to substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
 - 2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
- H. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws.
- I. Prime-Coat Finish: Manufacturer's standard prime-coat finish ready for field painting.
- J. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
 - 1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
 - 3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I clear coating of 0.018 mm or thicker), complying with AAMA 611.
 - 4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.
- K. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
 - 3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected by Engineer from manufacturer's full range.

- L. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 - 2. Powder coat shall comply with AAMA 2604.
 - a. Electrostatic applied powder coating; single application with a minimum 2.5- to 3.5-mils (64- to 89-um) dry film thickness; cured according to manufacturer's instructions. Coat interior and exterior of pole for equal corrosion protection.
 - b. Color: As selected by Engineer from manufacturer's full range.

2.3 PRESTRESSED CONCRETE POLES

- 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. Lithonia Lighting; Acuity Brands Lighting, Inc.
 - 2. Pre-Cast Specialties, Inc.
 - 3. Seminole Pole, Inc.
- B. Poles: Comply with ASTM C1089 and manufactured by centrifugal spin-casting process.
 - 1. Shape: Square, tapered.
 - 2. Mounting Provisions: Embedded.
 - 3. Finishing: Capped at top and plugged at bottom. Seat each reinforcing strand with epoxy adhesive.
 - 4. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole and attach to 24-inch lighting rod.
 - 5. Raceway: Smooth, internal, and not less than 3 inches in diameter.
- C. Concrete: Minimum 28-day compressive strength of 7000 psi.
- D. Cured with wet steam and aged for a minimum of 15 days prior to installation.
- E. Reinforcement: Reinforcing bars complying with ASTM A615/A615M.
- F. Surface Treatment: Hard, nonporous, and resistant to water, frost, and road and soil chemicals; and shall have a maximum water-absorption rate of 3 percent.
- G. Finish Texture: Standard form.
- H. Fasteners: Stainless steel, size and type as determined by manufacturer. Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.
- I. Nameplate: Aluminum cast into pole wall at approximately 5 feet above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.

- J. Pole Brackets: Comply with ANSI C136.31.

2.4 POLE ACCESSORIES

- A. Duplex Receptacle: Ground-fault circuit interrupter type, 120 V ac, 20 A in a weatherproof assembly. Comply with requirements in Section 262726 "Wiring Devices."
1. Surface mounted 12 inches above finished grade.
 - a. NEMA 250, Type 3R, nonmetallic polycarbonate plastic or reinforced fiberglass, enclosure with cover; color to match pole.
 - b. Lockable hasp and latch complying with OSHA lockout and tag-out requirements.
- B. Minimum 1800-W transformer, protected by replaceable fuses, mounted behind access cover.
- C. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.
- D. Transformer-Type Base: Same material and color as pole. Coordinate dimensions to suit pole's base flange and to accept indicated accessories. Include removable flanged access cover secured with bolts or screws.

2.5 MOUNTING HARDWARE

- A. Anchor Bolts: Manufactured to ASTM F1554, Grade 55, with a minimum yield strength of 55,000 psi.
1. Galvanizing: Mechanically deposited galvanization according to ASTM B695, Class 50.
 2. Bent rods <Insert inches> in diameter by <Insert inches> in length.
 3. Threading: Uniform National 8, Class 2A.
- B. Nuts: ASTM A563, Grade A, Heavy-Hex
1. Galvanizing: Mechanically deposited galvanization according to ASTM B695, Class 50.
 2. Four nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.
- C. Washers: ASTM F436, Type 1.
1. Galvanizing: Mechanically deposited galvanization according to ASTM B695, Class 50.
 2. Two washer(s) provided per anchor bolt.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine poles, luminaire-mounting devices, lowering devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
- C. Examine roughing-in for foundation and conduit to verify actual locations of installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 POLE FOUNDATION

- A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Pre-Cast Foundations: Factory fabricated, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- C. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories.
 - 1. Baseplate: Stamped with manufacturer's name, date of production, and cable entry.
- D. Direct-Buried Foundations: Install to depth indicated on Drawings, but not less than as indicated. Add backfill in 6-inch to 9-inch layers, tamping each layer before adding the next. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
- E. Direct-Buried Poles with Concrete Backfill: Set poles in augered holes to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height. To ensure a plumb installation, continuously check pole orientation with plumb bob while tamping.
 - 1. Make holes 6 inches in diameter larger than pole diameter.
 - 2. Fill augered hole around pole with air-entrained concrete having a minimum compressive strength of 3000 psi at 28 days and finish in a dome above finished grade.
 - 3. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

4. Cure concrete a minimum of 72 hours before performing work on pole.

F. Anchor Bolts: Install plumb using manufacturer-supplied template, uniformly spaced.

3.3 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. Fire Hydrants and Water Piping: 60 inches.
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

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 diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.5 GROUNDING

- A. Ground Metal Poles and Support Structures: Comply with requirements in Section 260526 "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.
- B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundation.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. Inspect poles for nicks, mars, dents, scratches, and other damage.
 - 2. System function tests.

END OF SECTION 265613

SECTION 265619 – LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
 - 2. Luminaire supports.
 - 3. Luminaire-mounted photoelectric relays.

- B. Related Requirements:

- 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
 - 2. Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

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

- 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.

3. Include physical description and dimensions of luminaire.
 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 5. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-80.
 - a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 6. Wiring diagrams for power, control, and signal wiring.
 7. Photoelectric relays.
 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Shop Drawings: For nonstandard or custom luminaires.
1. Include plans, elevations, sections, and mounting and attachment details.
 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.
- D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For luminaire supports.
1. Include design calculations for luminaire supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Luminaires.
 2. Structural members to which equipment and luminaires will be attached.
 3. Underground utilities and structures.
 4. Existing underground utilities and structures.
 5. Above-grade utilities and structures.
 6. Existing above-grade utilities and structures.
 7. Building features.
 8. Vertical and horizontal information.
- B. Qualification Data: For testing laboratory providing photometric data for luminaires.

- C. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Product Certificates: For each type of the following:
 - 1. Luminaire.
 - 2. Photoelectric relay.
- E. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- F. Source quality-control reports.
- G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
 - 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 - 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 **<Insert quantity>** of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as

defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- F. Mockups: For exterior luminaires, complete with power and control connections.
 - 1. Obtain Engineer's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Engineer prior to the start of luminaire installation.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. UL Compliance: Comply with UL 1598 and listed for wet location.
- E. CRI of as indicated on the drawings. CCT of as indicated on the drawings.
- F. L70 lamp life of 50,000 hours.
- G. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- H. Internal driver.
- I. Nominal Operating Voltage: 120 V ac.
- J. In-line Fusing: Separate in-line fuse for each luminaire.
- K. Lamp Rating: Lamp marked for outdoor use.
- L. Source Limitations: Obtain luminaires from single source from a single manufacturer.
- M. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton (Lighting).
 2. Intermatic, Inc.
 3. Lithonia Lighting; Acuity Brands Lighting, Inc.
 4. Schneider Electric USA, Inc.
 5. Siemens Industry, Inc. (Building Technologies Division).
 6. Signify North America Corporation (formerly Philips Lighting).
- B. Comply with UL 773 or UL 773A.
- C. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.
1. Relay with locking-type receptacle shall comply with ANSI C136.10.
 2. Adjustable window slide for adjusting on-off set points.

2.4 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: As indicated on the drawings. Form and support to prevent warping and sagging.
- C. 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.
- D. Diffusers and Globes:
1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 2. Glass: Annealed crystal glass unless otherwise indicated.
 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- 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.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. 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.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

- a. Color: Dark bronze.

D. 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.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: As selected from manufacturer's standard catalog of colors.
 - b. Color: Match Engineer's sample of manufacturer's standard color.
 - c. Color: As selected by Engineer from manufacturer's full range.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine walls, roofs, for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- C. Install lamps in each luminaire.
- D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls or Attached to a minimum 1/8 inch backing plate attached to wall structural members.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 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 Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):
 - a. IES LM-5.
 - b. IES LM-50.
 - c. IES LM-52.
 - d. IES LM-64.
 - e. IES LM-72.
2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. 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.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Engineer.

END OF SECTION 265619

SECTION 311000 - SITE PREPARATION

PART 1 - GENERAL

1.1 SITE PREPARATION, CLEAN UP, AND RESTORATION

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Site Preparation, Clean Up and Restoration – Section 406.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 311000

SECTION 312000 - EXCAVATION AND EARTHWORK

PART 1 - GENERAL

1.1 EXCAVATION AND EARTHWORK

- A. A.As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Excavation and Earthwork – Section 408.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 312000

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 DEWATERING

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Dewatering – Section 408.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 312319

SECTION 312333 - TRENCHING, BACKFILLING, AND COMPACTION

PART 1 - GENERAL

1.1 TRENCH EXCAVATION AND BACKFILL

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Excavation and Earthwork – Section 408.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 312333

SECTION 312500 - EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Sediment Fences

- B. Related Sections:

- 1. Section 311000 – Site Preparation
 - 2. Section 312000 – Excavation and Earthwork
 - 3. Section 312333 – Trenching, Backfilling, and Compaction
 - 4. Section 321216 – Asphalt Paving
 - 5. Section 321313 - Concrete Work
 - 6. Section 329200 - Grassing

1.3 REFERENCE STANDARD

- A. EPA document titled: “Stormwater Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices” document number EPA 832-R-92-005, dated 1992, or most recent edition. State or appropriate Conservation Commission standards can be substituted for the EPA standard if the State or Conservation Commission standard is equal to, or more detailed than, the EPA standard.

1.4 ACTION SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
 - 1. Submit, within 10 days after award of Contract, technical product literature for all commercial products.
- B. Product Data: Product Data: Submit data on silt fencing.
- C. Submit schedule for temporary erosion and sedimentation controls.

1.5 INFORMATIONAL SUBMITTALS

- A. Stormwater Pollution Prevention Plan (SWPPP) as specified in “Quality Assurance” article.

1.6 CLOSEOUT SUBMITTALS

- A. Section 017700 “Closeout Procedures”: Requirements for submittals.

1.7 QUALITY ASSURANCE

- A. Prepare and submit a Stormwater Pollution Prevention Plan (SWPPP) in accordance with the U.S. Environmental Protection Agency (EPA) National Pollution Discharge Elimination System (NPDES) General Permit applicable to this work) document number EPA 832-R-92-005, dated 1992, or most recent edition. Maintain one copy on site.
- B. Prepare and submit the EPA NPDES Notice of Intent to Discharge to the applicable EPA office in accordance with EPA regulations.

PART 2 - PRODUCTS

2.1 SILT FENCE

- A.
 - A. Sediment fence shall be a prefabricated commercial product made of a woven, polypropylene, ultraviolet resistant material such as “Envirofence” by Mirafi Inc., Charlotte, NC or equal.

PART 3 -

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017300 - Execution: Verification of existing conditions before starting work.

3.2 SILT FENCE

- A. Position sediment fences as indicated on the Drawings and to prevent off site movement of sediment produced by construction activities as directed by the Engineer. Areas beyond limits of silt fence shall be undisturbed or stabilized.
- B. Install pre-fabricated silt fence according to manufacturer's instructions.

3.3 SITE STABILIZATION

- A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

- B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.
- C. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2: 1 or flatter.
- D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.
 - 1. During non-germinating periods, apply mulch in accordance with Florida Department of Transportation (FDOT) Section 570-1 through 570-3 of the FDOT Specifications.
 - 2. Stabilize disturbed areas which are not at finished grade and which will be disturbed within one year in accordance with Section 570-1 through 570-3 of the FDOT Specifications .
 - 3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 329200 permanent seeding specifications.
- E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.4 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements and 017300 - Execution: Field inspecting, testing, adjusting, and balancing.
- B. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.

3.5 CLEANING

- A. Section 017300 "Execution" and 017700 "Closeout Procedures": Requirements for cleaning.
- B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.
- C. Do not damage structure or device during cleaning operations.
- D. Do not permit sediment to erode into construction or site areas or natural waterways.
- E. Clean channels when depth of sediment reaches approximately one-half channel depth.

3.6 PROTECTION

- A. Section 017300 "Execution": Requirements for protecting finished Work.

END OF SECTION 312500

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Asphalt materials.
2. Aggregate materials.
3. Aggregate base.
4. Subgrade preparation.

- B. Related Requirement:

1. Section 312000 - Excavation and Earthwork.

1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.

- B. Product Data:

1. Submit product information for asphalt and aggregate materials.
2. Submit mix design with laboratory test results supporting design.

- C. Manufacturer's Certificate: Certify products meet or exceed physical qualities specified.

1.4 QUALITY ASSURANCE

- A. Mixing Plant: Certified by Florida Department of Transportation (FDOT).

- B. Obtain materials from same source throughout.

- C. Perform Work in accordance with Florida Department of Transportation Standard Specifications for Road and Bridge Construction (latest edition).

PART 2 - PRODUCTS

2.1 BASE AGGREGATE MATERIALS

1. Limerock base course shall be 12-inch minimum thickness with a minimum Limerock Bearing Ratio (LBR) of 75 compacted to 100 percent of the Modified Proctor maximum dry density (AASHTO T-180).
2. Limerock for the base course shall be classified either as Ocala Formation or a Miami Oolite Formation limerock. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted. The minimum of carbonates of calcium and magnesium in the limerock material shall be 70 percent. The liquid limit shall not exceed 35 and the material shall be non-plastic. Limerock shall not contain cherty or other extremely hard pieces, lumps, balls or pockets of sand or clay size material in sufficient quantity as to be detrimental to the proper bonding, finishing or strength of the limerock base

2.2 ASPHALT PAVING

A. Asphalt Materials:

1. Prime Coat: The material used for the prime coat shall conform with Section 300 of the FDOT Specifications for primer to be used on Miami Oolite limerock base.
2. Asphalt Concrete: The materials for the asphaltic concrete surface shall conform with applicable sections of FDOT Specifications, Sections 330 and 916 for Type SP12.5 Asphaltic Concrete Surface Course.
3. Tack Coat: Bituminous material for tack coat shall conform with Section 916 of the FDOT Specifications for the grade used and may be any suitable grade of R.C.

2.3 MIXES

- A. Use dry material to avoid foaming. Mix uniformly.
- B. Asphalt Paving Mixtures: The asphalt paving mixtures shall conform with applicable sections of FDOT Specifications, Sections 330 and 916 for Type SP12.5 Asphaltic Concrete Surface Course.

2.4 SOURCE QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.
- B. Perform tests necessary to locate acceptable source of aggregate materials meeting specified requirements.
- C. Final approval of aggregate material will be based on test results of installed materials.
- D. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

- E. Submit proposed mix design for review prior to beginning of Work.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017300 "Execution": Requirements for installation examination.
- B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted. Once final lift of subgrade is compacted, no further trenching shall be allowed for utilities or other purposes.
- C. Verify compacted subgrade is free of water, debris, and foreign matter during compaction or proof-rolling.
- D. Correct ruts or soft yielding spots in the underlying courses.
- E. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- F. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
- G. Maintain prepared ground surface in finished condition until next course is placed.
- H. Bearing Value Requirement: The completed subgrade shall be constructed to obtain a minimum Limerock Bearing Ratio (LBR) shown in the Drawings and Specifications. The Contractor shall obtain and submit test results from an approved independent testing laboratory showing results.
- I. Verify manhole frames, valve boxes, and other utility castings are installed in correct position and elevation.

3.2 PREPARATION

- A. Proof roll the subgrade with at least 15 overlapping passes using a vibratory roller having a minimum dynamic force of 10 tons. After proof rolling, compact the upper 12 inches to minimum 90 percent compaction, as determined in accordance with ASTM D1557. Densities should be uniformly obtained within each lift of structural fill or backfill.
- B. The preparation of the asphalt cement, aggregates and mixture shall conform to FDOT Specification Section 330-4, 5, and 6.

3.3 DEMOLITION

- A. Saw cut and notch existing paving as indicted on Drawings.
- B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

3.4 INSTALLATION

- A. The top 12 inches of the sub-grade, in both cut and fill sections, shall be compacted to a density of at least 90 percent of the soil's maximum dry density as determined by ASTM D1557. All subgrade compaction shall be performed "in the dry". Proper moisture control shall be maintained throughout the compaction process. The sub-grade shall be shaped prior testing and verifying compaction. The required density shall be maintained until the base or pavement has been laid or until the aggregate materials for the base or pavement course have been spread in place.
- B. Untreated Aggregate Base Course:
1. Maximum Completed Lift Thickness: 4 inches. The 12-inch base shall be constructed in three courses. The thickness of the first course shall be approximately 4 inches.
 2. Completed Course Total Thickness: 12 inches.
 3. Spread lift on preceding course to required cross-section.
 4. Lightly blade and roll surface until thoroughly compacted.
 5. Commence compaction of each layer of base after spreading operations and continue until density of 100 percent of Modified Proctor maximum density has been achieved as determined by AASHTO T180. Place and compact each lift to required density before succeeding lift is placed.
 6. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:
 - a. Use leveling course or surfacing material as keystone.
 - b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
 - c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
 - d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
 7. Blade or broom surface to maintain true line, grade, and cross-section.
- C. Primer:
1. Before the prime coat is applied, all loose material, dust, dirt or other foreign material which might prevent bond with existing surface shall be moved to the shoulders to the full width of the base by means of revolving brooms, mechanical sweepers, blowers supplemented by hand sweeping or other methods approved by the Engineer. The glazed finish shall have been removed from the base. The prime coat shall be applied by a pressure distributor so that approximately 0.1 gallons per square yard is applied uniformly and thoroughly to a clean surface.
 2. Apply primer in accordance with Florida Department of Transportation standards.
- D. Tack Coat:
1. Apply bituminous tack coat at a rate between 0.02 and 0.10 gallons per square yard. Bituminous material shall be heated as per Manufacturer's recommendations.
- E. Asphalt Paving:

1. Limitations of Operations: The laying operations shall not begin unless the weather is suitable for all activities to be completed in dry conditions.
2. The mixture shall be transported as specified in FDOT Specification Section 330-7.
3. Prepare joints in accordance with Section 330-11 of the FDOT Specifications. Maintain a smooth transition between existing and new pavement.
4. Placing the mixture shall conform to FDOT Specification Section 330-9. Lift thickness shall be as shown on the drawings.
5. Compaction of the asphaltic concrete shall be in accordance with the FDOT Specification Section 330-10. Compact to an average density of at least 98 percent of the valid control strip density. The control strip density is determined by the method defined in Section 330-11.3.2 of the FDOT Specifications.
6. The surface shall conform to the FDOT Specification Section 330-12.4, except that the criteria for the maximum allowable deficiency in the final surface layer shall be 3/16 inch for all locations and types of paved areas. The finished surface must be of uniform texture and compaction. Any pulled, torn, or loosened asphalt, or any areas with open pores, segregation, sand streaks, sand spots, or ripples must be corrected. Correct thickness deficiencies by either replacing the full thickness for a length extending at least 50 feet beyond each end of the deficient area, for the full width of the paving lane, or (when permitted by the Owner) by overlaying.

3.5 PAVEMENT REPAIR

- A. All damage to pavement as a result of work (construction or maintenance) under this contract shall be repaired in a manner satisfactory to the Engineer and at no additional cost to the OWNER. Pavement shall be repaired to match the original surface material and original grade. However, the asphalt concrete thickness shall not be less than 2 inches. The repair shall include the preparation of the sub-grade, the placing and compacting of the limerock base, the priming of the base, the placing and maintaining of the surface treatment, all as specified herein.
- B. The width of all repairs shall extend at least 12 inches beyond the limit of the damage. The edge of the pavement to be left in place shall be cut to a true edge with a saw or other approved method so as to provide a clean edge to about the repair. The line of the repair shall be reasonably uniform with no unnecessary irregularities.

3.6 TOLERANCES

- A. Section 014000 - Quality Requirements: Tolerances.
- B. Base Aggregate
 1. Flatness: Maximum variation of 1/2 inch measured with 10 foot straight edge.
 2. Scheduled Compacted Thickness: Within 1/2 inch.
 3. Variation from Indicated Elevation: Within 1/2 inch.
- C. Asphalt Pavement
 1. Flatness: Maximum variation of 1/2 inch measured with 10 foot straight edge.
 2. Scheduled Compacted Thickness: Within 1/4 inch.
 3. Asphalt Variation from Indicated Elevation: Within 3/16 inch.

3.7 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting, testing.
- B. Subgrade Field Density Measurements: Measure field density in accordance with ASTM D1557.
- C. Base Aggregate Field Density Measurements: Measure field density in accordance with AASHTO T-180.
- D. Asphalt Pavement Field Density Measurements: Measure field density in accordance with FDOT Specifications Section 330-11.3.2.

3.8 PROTECTION

- A. Section 017300 "Execution": Requirements for protecting finished Work.
- B. The Contractor shall protect the finished asphaltic concrete pavement surface upon completion. No dumping of any material directly on the pavement shall be permitted. Vehicular traffic shall not be permitted on any pavement that has not set sufficiently to prevent rutting or other distortion.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 CONCRETE PAVEMENT

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Concrete Work – Section 437.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 321313

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 CHAIN LINK FENCES

- A. Fencing and gates shall be as specified in the JEA Water and Wastewater Standards (January 2020 or latest), Fencing – Section 492.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 323113

SECTION 329200 - GRASSING

PART 1 - GENERAL

1.1 GRASSING

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Grassing – Section 441.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 329200

SECTION 330507.13 - HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 HORIZONTAL DIRECTINAL DRILLING

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Horizontal Directional Drilling (Large Diameter Pipe Greater Than 12 Inches) – Section 755.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 330507.13

SECTION 330513 - PRECAST MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 PRECAST MANHOLES AND STRUCTURES

- A. As specified in the JEA Water and Wastewater Standards (January 2020 or latest), Wastewater Manholes – Section 427.

PART 2 - PRODUCTS

PART 3 - EXECUTION

END OF SECTION 330513

SECTION 331113.13 - DUCTILE IRON PIPE AND FITTINGS (BELOW GRADE)

PART 1 - GENERAL

1.1 WASTEWATER FITTINGS

- A. Shall be as specified in the JEA Water and Wastewater Standards (January 2020 or latest), Wastewater Force Mains – Section 429.
- B. Shall be as specified in the JEA Water and Wastewater Standards (January 2020 or latest), Wastewater Valves and Appurtenances – Section 430.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 331113.13

SECTION 333400 - POLYVINYL CHLORIDE PRESSURE PIPE (BELOW GRADE)

PART 1 - GENERAL

1.1 POLYVINYLE CHLORIDE PRESSURE PIPE (BELOW GRADE)

- A. Shall be as specified in the JEA Water and Wastewater Standards (January 2020 or latest), Wastewater Force Mains – Section 429.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 333400

SECTION 339050 - VALVES, HYDRANTS, AND APPURTENANCES

PART 1 - GENERAL

1.1 VALVES, HYDRANTS AND APPURTENANCES

- A. Shall be as specified in the JEA Water and Wastewater Standards (January 2020 or latest), Water Meters, Valves and Appurtenances – Section 351.
- B. Shall be as specified in the JEA Water and Wastewater Standards (January 2020 or latest), Wastewater Valves & Appurtenances – Section 430.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 339050

SECTION 406100 - PROCESS CONTROL AND ENTERPRISE MANAGEMENT SYSTEMS GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes procurement of the services of a Process Control System Supplier (PCSS) to furnish and install all materials, equipment, labor and services, required to achieve a fully integrated and operational system as specified herein, in "Related Requirements" under this Article, and in related drawings, except for those services and materials specifically noted.
- B. The responsibilities of the PCSS shall be generally as follows:
 - 1. Furnish and install all field instrumentation as listed in Section 407000.
 - 2. Provide all control panels as listed in Section 406717.
 - a. Within the network rack at each pump station, provide an Ethernet switch designated for security equipment.
 - b. Seven (7) calendar days prior to the commencement of shop drawing submission, the PCSS shall obtain confirmation in writing whether the programmable logic controller (PLC) to be used in this project shall be the Siemens S7-300 series as specified in Section 406343, or shall be the Siemens S7-1500 series.
 - 3. Provide and install a radio antenna and pole or tower, along with coaxial cable and required surge protection and grounding, at each pump station (118th Street and Wilson Blvd) for communication of data between the respective pump station and the OWNER's SCADA network, as shown in the Drawings. Existing radios and antennas shall be used. Antennas, poles and towers are specified in "JEA Water & Wastewater Standards Manual" (rev. 1/1/2019), Section 433, paragraph VI.4.7. Coordinate with the Electrical subcontractor regarding the installation, and termination of cables. Coordinate with the OWNER for radio survey information.
- C. The following activities are excluded from the PCSS scope of supply:
 - 1. Coordinate with the Electrical subcontractor regarding the provision, installation, and termination of cables.
 - 2. The OWNER will provide a radio survey that will indicate the expected required height and orientation of the radio antenna.
 - 3. The OWNER will provide all equipment, cables, and installation for the security system.
 - 4. The OWNER will provide all programming for the PLC to be furnished under this Section, the operator interface terminal (OIT), and the human-machine interface (HMI).

The PCSS shall provide only temporary PLC programming where it is necessary to facilitate testing. Refer to Section 406121.

- D. Include auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, whether indicated on the Drawings or not.
- E. All equipment and installations shall satisfy applicable Federal, State and local codes. Refer to Electrical drawings for area classifications for Class and /Division ratings.
- F. Use the equipment, instrument, and loop numbering scheme indicated on the Drawings and in the specifications in the development of the submittals. Do not deviate from or modify the numbering scheme.

1.3 DEFINITIONS

- A. PCSS – Process Control System Supplier.
- B. MOPO - Maintenance of Plant Operations.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 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 of equipment, control panels, and instrumentation as specified herein.
 - 4. Include diagrams for power, signal, and control wiring.
- C. Input/Output (I/O) List Submittal:
 - 1. Submit a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
 - 2. I/O list shall be based on the P&ID's, the Drawings, the design I/O list (if included), and requirements in the Specifications.
 - 3. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format and an 8-1/2 inch by 11-inch PDF/hard copy.

4. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O as required in the specifications.
5. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet shall include the following information:
 - a. TAG NUMBER(S): As indicated on the Drawings, the identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
 - b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
 - c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
 - d. PHYSICAL POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
 - e. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO - Pulse Output.
 - f. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
 - g. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
 - h. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
 - i. P&ID - the P&ID or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the P&IDs.
 - j. LOGICAL POINT ADDRESS: I/O address of each point.
6. The I/O list shall be sorted in order by:
 - a. Physical location.
 - b. I/O Type.
 - c. Loop Number.
 - d. Device Tag.
7. Once the I/O list is approved, the PLC I/O addresses shall not be modified without approval by the Engineer.
8. For I/O layout requirements, see Section 406343 .

D. Field Instruments Submittal:

1. Refer to Section 407000.

E. Control System Architecture, Computer Equipment Rack,, Hardware and Software Packages Submittal:

1. Refer to the sections below for equipment required as part of the submittal:
 - a. Section 406263, Operator Interface Terminals
 - b. Section 406343, Programmable Logic Controllers
 - c. Section 406613, Switches and Routers
 - d. Section 406717, Industrial Enclosures

- e. Panel-mounted equipment in Sections 4067XX and 4078XX
- 2. For each hardware and software packages component specified in the sections above, submit a cover page that lists, at a minimum, date, specification number, product name, manufacturer, model number, location(s), and power required. Preferred format for the cover page is ISA-TR20.00.01-2001 (updated in 2004-2006), general data sheet; however, other formats will be acceptable provided they contain all required information.
 - 3. Complete system architecture drawing(s) showing in schematic form showing the interconnections between major hardware components including, control panels, computers, networking equipment, control panels with PLC systems and I/O modules, local operator interfaces, process equipment vendor panels with PLCs, and networked peripherals such as power monitors, security cameras, etc.
 - 4. The system architecture drawing(s) shall be developed in accordance with the following information and guidelines at a minimum:
 - a. Show power connections to each piece of equipment or grouping of equipment with voltage and power sources noted such as 120VAC UPS battery, 24VDC battery, or 120VAC from LP (lighting panel). Indicate specific UPS number or circuit number whenever possible.
 - b. All communication cable types should be uniquely identified with a specific line type and cable characteristics clearly indicated in a key or legend located on drawing(s). For example, 50/125 micron multimode mode fiber, or CAT-6E Ethernet copper cabling. Any multiconductor communication cables will be clearly labeled above each individual communication with a note added to drawing that states if no quantity exists above a line type, there is only one communication cable between devices. If a multi-conductor cable has multiple colors, legend shall clearly indicate which colors are used for which networks (i.e., a multi-pair fiber optic cable used for dedicated networks such as SCADA, Electrical, Security, HVAC, etc.)
 - c. All communication cables need to be assigned a unique cable identification label and shown in either a table or above the communication line.
 - d. Network protocols shall be clearly identified for each communication path or for system and indicated in a key or legend as appropriate. Examples are Allen-Bradley EtherNet/IP, Modbus TCP/IP, or DNP3.
 - e. Any device that has multiple ports or connection points, shall clearly indicate which port or connection number the communication cable is terminating at. For multiple devices, this could be shown once in a key or legend and noted on architecture as appropriate.
 - f. For each PLC control panel or network communication enclosure provided by PCSS, the architecture drawing shall clearly reference other drawings provided by the PCSS for detailed panel wiring diagrams with a note near that PLC panel or communication enclosure indicating referenced drawing numbers. A placeholder is acceptable at the time of submission if these drawings are to be submitted at a later date.
 - g. Use symbology and/or icons whenever possible to represent a device and differentiate between devices that are different form factors (i.e. tower computer vs. desktop computer vs. rack mounted). Vendor CAD libraries are preferred for symbols.
 - h. The intent of this specification requirement is to develop a diagram that will allow a qualified technician to interconnect all equipment without having to refer to additional manuals or literature.

- i. Sheet size shall be 11"x17" minimum and using more than one sheet is acceptable with a logical breakout between sheets (i.e., head end on one sheet and plant control system on another). Line continuations must between drawings must be clearly identified.

F. Panel Layout Drawings and Wiring Diagrams Submittal:

1. Panel Layout Drawings: Submit Drawings for all panels specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11"x17" in size. At a minimum, the panel drawings shall include the following:
 - a. A legend sheet clearly indicating all symbols used on drawings and with voltage, color and size of each wire clearly indicated and in accordance with requirements of Section 406733 – Panel Wiring.
 - b. Interior and exterior panel elevation drawings to scale.
 - c. Nameplate schedule.
 - d. Conduit access locations.
 - e. Panel construction details.
 - f. Cabinet assembly and layout drawings to scale. Assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. Bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify all components of the assembly by manufacturer and model number.
 - g. Fabrication and painting specifications including color (or color samples).
 - h. Construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
 - i. For all control panels located in outdoor areas or non-conditioned indoor areas, provide heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
 - j. Submit evidence that all control panels shall be constructed in conformance with UL 508A and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. Costs associated with obtaining the UL seal and any inspections shall be borne by Contractor.
2. Wiring Diagrams Submittal:
 - a. Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. Diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on equipment not supplied by the PCSS. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the PCSS and approved by the Engineer. I/O wiring shall be numbered with rack number, slot number, and

point number. Two-wire and four-wire equipment shall be clearly identified, and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11" x 17" in size.

3. Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in Adobe Acrobat PDF format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.

G. Testing Submittals:

1. Refer to Section 406121 for specific testing submittal requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all PCSS supplied hardware to include in **operation** and maintenance manuals.

1. Submit in accordance with Section **017823 - Operation and Maintenance Data**.
2. The operations and maintenance manuals shall, at a minimum, contain the following information:

a. Table of Contents:

- 1) A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.

b. Instrument and Equipment Lists:

- 1) The following lists shall be developed in Microsoft Excel format:
 - a) An instrument list or spreadsheet for all instruments supplied including tag number, description, specification section and paragraph number, manufacturer, model number, calibrated range, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.
 - b) An equipment list or spreadsheet for all non-instrument devices supplied listing description, specification section and paragraph number, manufacturer, model number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.

c. Equipment Operations and Maintenance Information:

- 1) ISA-TR20.00.01-2001(updated in 2004-2006) data sheets shall be provided for all field instruments. For non-field instrumentation devices, provide a cover page for each device, piece of equipment, and OEM software that lists date, specification number, product name, manufacturer, model number,

Location(s), and power required. Preferred format for the cover page is ISA-TR20.00.01-2001(updated in 2004-2006), general data sheet; however, other formats will be acceptable provided they contain all required information.

- 2) Vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages or sections that do not apply at all to the specific model supplied shall be removed.
- 3) Provide the record documentation of the completed test forms with sign-offs as specified in Section 406121 - Testing.
- 4) Provide instrument/equipment calibration and configuration forms as specified in Section 406121 - Testing.

d. As-Built Drawings:

- 1) Complete as-built drawings, including all drawings and diagrams specified in this section under the "Submittals" section. These drawings shall include all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the PCSS. Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in Adobe Acrobat format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.
- 2) As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.

3. Electronic O&M Information:

- a. In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals and data sheets, along with any software back-up of configuration files, on DVD or USB thumb drive. Electronic documents shall be supplied in Adobe Acrobat format.
- b. Provide electronic files for all custom-developed manuals including training manuals. Text shall be supplied in both Microsoft Office format and Adobe Acrobat format.
- c. Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in Adobe Acrobat format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.
- d. Each computer system hardware device shall be backed up onto DVD or USB thumb drive after Substantial Completion and shall be turned over to the Owner.
- e. If specified in the training section, provide digital copies of all training videos. Videos shall be in a format that is readable by standard DVD players and by standard PC DVD drives. Format shall be a minimum of 800 by 600 pixels and shall include sound.

1.6 MAINTENANCE MATERIAL SUBMITTAL

- A. Furnish extra materials from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Refer to individual specification sections in Division 40 6X XX through 40 78 XX for spare equipment requirements and provide one comprehensive spare parts submittal for project.
- B. All spare parts shall be packed in individual cartons and labeled with indelible markings clearly indicating component(s) inside. Complete ordering information paperwork including manufacturer's contact information (address and phone number), part name, part number, equipment name and tag number(s) for which the part is to be used (if applicable) shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by the Owner or Engineer.

1.7 QUALITY ASSURANCE

- A. The Process Control System Supplier (PCSS) shall be a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. For the purposes of this Specification Section, a "systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:
 - 1. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. Key personnel shall hold ISA CCST Level 1 certification or have a minimum of 10 years of verifiable plant startup experience. Key personnel shall include, as a minimum, the lead field technician.
 - 2. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Successful completion shall be defined as a finished project completed on time, without any outstanding claims or litigation involving the PCSS. Potential references shall be for projects where the PCSS's contract was of similar size to this project.
 - 3. Has been actively engaged in the type of work specified in this Section for a minimum of five years.
- B. The PCSS shall maintain a permanent, fully staffed and equipped service facility within <xxx> miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the PCSS shall be capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.
- C. The selected PCSS shall be one of the following:
 - 1. DSI Innovations LLC
13400 Sutton Park Dr S, Suite 1001
Jacksonville, FL 32224

TEL: (336) 893-8385
ATTN: Damien Johns

2. Infamation Technologies Group (ITG)
11235 St. John's Industrial Parkway North, Unit #2
Jacksonville, FL 32246
TEL: (904) 425-4760
ATTN: Dale Young

- D. Being listed in this specification does not relieve any potential PCSS from meeting the qualifications specified in this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 016000 "Product Requirements" for delivery, storage, and handling requirements.

1.9 FIELD CONDITIONS

- A. Environmental Requirements. Refer to Section 26 xx xx - Insert Section Title and Electrical Drawings for specific environmental and hazardous area classifications.
- B. Elevation: Equipment shall be designed to operate at the project ground elevation.
- C. Temperature:
 1. Outdoor areas' equipment shall operate between -30 to 50 C degrees ambient.
 2. Equipment located in indoor locations shall operate between 10 to 35 C degrees ambient minimum.
 3. Storage temperatures shall range from 0 to 50 C degrees ambient minimum.
 4. Additional cooling or heating shall be furnished if required by the equipment as specified herein.
 5. Relative Humidity. Air-conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between 5 to 100 percent relative, condensing humidity.
- D. None of the control system equipment located in the control room shall be shipped to the site until the control room areas comply with specified ambient temperature and humidity and free of dust and debris.

1.10 WARRANTY

- A. Warranty Period: One year from date of Substantial Completion unless noted otherwise in individual specification sections.

PART 2 - PRODUCTS

2.1 GENERAL

A. Electrical Requirements for Control System:

1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).
3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.
4. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.
5. Switches and/or signals indicating an alarm, failure or upset condition shall be wired in a fail-safe manner. A fail-safe condition is when an open circuit generates an alarm state (i.e. contact opens).
6. Materials and equipment shall be UL approved whenever such approved equipment and materials are available.
7. All equipment furnished shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.
8. Surge protection requirements for control system power, signal, and communication lines are specified in Section 407856 – Isolators, Intrinsically Safe Barriers, and Surge Suppressors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine equipment before installation. Reject products or materials that are wet, moisture damaged, or mold damaged.
- C. Examine walls, floors, and roofs for suitable conditions where control panels and instrumentation will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 GENERAL INSTALLATION

- A. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.
- B. Provide sunshades for equipment mounted outdoors in direct sunlight. Include sunshades standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North to minimize the impact of glare and ultraviolet exposure on digital readouts.

3.3 IDENTIFICATION

- A. Provide identification system for all PCSS provided hardware, instrumentation, and communication cabling, as detailed in individual equipment Sections.

3.4 STARTUP SERVICE

- A. Refer to Section 406121 - Process Control System Testing.
- B. On-site coordination meetings with Engineer, Contractor, Vendors, and Owner as required during active construction period.

END OF SECTION 406100

SECTION 406121 - PROCESS CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Section 406100.

1.2 SUMMARY

- A. Section includes control system testing.
- B. Furnish all labor, materials, equipment and incidentals required to complete the testing of all devices and systems furnished and installed as detailed on Drawings, and as specified herein.
- C. Refer to Section 406100 for a description of the project scope, and other general requirements.

1.3 ACTION SUBMITTALS

- A. Refer to Section 406100.
- B. Testing Submittals:
 - 1. Test Form Submittals: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each testing activity with sign-off areas for the PCSS, ENGINEER, and OWNER, as applicable. Submit separate forms and procedures for each specified test phase.
 - 2. Detailed requirements for Test Forms:
 - a. Each loop shall have a Loop Status signoff form to organize and track its inspection, adjustment and calibration. These forms shall include the following information and checkoff items:
 - 1) Project Name.
 - 2) Loop Number.
 - 3) Detailed test procedure indicating exactly how the loop will be tested including all required test equipment, necessary terminal block numbers, and simulation techniques required.
 - 4) Tag Number for each component.
 - 5) Checkoffs/signoffs for each component.
 - 6) Tag/identification
 - 7) Installation
 - 8) Termination wiring

- 9) Termination tubing
 - 10) Calibration/adjustment
 - 11) Checkoffs/signoffs for the loop.
 - 12) Panel interface terminations
 - 13) I/O interface terminations
 - 14) I/O signal operation
 - 15) Inputs/outputs operational: received/sent, processed, adjusted
 - 16) Total loop operation
 - 17) Space for comments.
 - 18) Sign off and date fields for the CONTRACTOR, the ENGINEER, and the ISS.
- b. Each field instrument, or other active analog subsystem element, shall have a Component Calibration form. These forms shall have the following information including space for data entry:
- c. Project Name.
- 1) Loop Number.
 - 2) ISA Tag Number and I/O Module Address.
 - 3) Manufacturer.
 - 4) Model Number/Serial Number.
 - 5) Summary of Functional Requirements. For example:
 - 6) For Indicators: Scale ranges
 - 7) For Transmitters/Converters: Scale and chart ranges
 - 8) For Computing Elements: Function
 - 9) For Controllers: Action (direct/reverse) control modes (PID)
 - 10) For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL)
 - 11) For I/O Modules: Input or output
 - 12) Calibrations; for example:
 - 13) For Analog Devices: Required and actual inputs and outputs at 0, 50 and 100 percent of span.
 - 14) For Discrete Devices: Required and actual trip points and reset points.
 - 15) For Controllers: Mode settings (PID).
 - 16) For I/O Modules: Required and actual inputs or outputs for 0, 50 and 100 percent of span.
 - 17) Space for comments.
 - 18) Sign off and date fields for the CONTRACTOR, the ENGINEER, and the ISS.
3. Test Documentation:
- a. Upon completion of each required test, document the test by submitting a copy of the signed-off test procedures. A test shall not be considered complete until the signed-off test procedures have been submitted and approved. Submittal of other test documentation is not an acceptable substitute for the formal test documentation.
 - b. For the UFT, also provide digital photos and/or videos that clearly show that the panel size, finish, layout, components, construction, etc., are correct and in conformance with Drawings, Specifications, and approved shop drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING - GENERAL

- A. Refer to Section 406100.
- B. Results of all testing shall be tracked on a project specific status sign off form or similar document. PCSS shall be responsible for maintaining the sheet. Appendix of this Section has an example template for this sheet.
- C. Tests the PCSS is required to perform are as follows:
 - 1. Factory Testing:
 - a. Unwitnessed Factory Test (UFT).
 - 2. Field Testing:
 - a. Operational Readiness Test (ORT).
 - b. Site Acceptance Test (SAT).
- D. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide all special testing materials and equipment required for a suitable means of simulation.
- E. The PCSS shall provide all facilities, materials and equipment required to conduct the test, at no additional cost to the OWNER. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation. The ISS shall describe planned simulation techniques in the test submittal(s).
 - 1. For PLC I/O testing, the PCSS shall use SIMATIC STEP 7 software.
 - 2. The PCSS shall furnish temporary PLC programming for I/O checkout if necessary to facilitate the testing procedures required herein.
- F. The PCSS shall furnish the services of field service engineers, all special calibration and test equipment, and labor to perform the field tests. The PCSS shall be responsible to enlist the services of the Control Panel Builder as required during all applicable testing.
- G. PCSS shall coordinate all required testing with Contractor, affected Subcontractors, Engineer, and Owner.
- H. No equipment shall be shipped to jobsite until Engineer or Owner has received all Factory Testing results and approved the system as ready for shipment.
- I. Engineer reserves the right to test or re-test any functions.

J. Correction of Deficiencies:

1. Deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to Owner.
2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until specified requirements are met. This work shall be performed at no additional cost to Owner.

3.2 FACTORY TESTING - UNWITNESSED FACTORY TEST (UFT)

- A. Purpose of UFT is for PCSS to check system prior to Engineer and/or Owner attending factory testing. This type of testing shall be part of any quality firm's internal QA/QC procedures.
- B. Temporary network connections will be required to confirm the network configuration. Temporary wiring of primary elements, final control elements, and field-mounted transmitters is not required.
- C. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in Test Procedure submittal.
 1. All panels and enclosures being provided shall undergo a thorough inspection to verify integrity of cabinet enclosures, frame structures, paint work and finish, etc. Review panel drawings to ensure they accurately reflect panel layout and wiring.
 2. Perform a system audit to verify all components have been staged for test and have been documented properly with correct model numbers, serial numbers, etc. Following documentation of audit shall be provided at factory test and submitted as part of O&M Manual Documentation:
 - a. For each workstation and server, list of all software installed (including the operating system), with software revision number, software improvement modules or patches installed, license number and owner registration information, warranty period, vendor and local distributor names and contacts.
 - b. For each microprocessor-based component connected to control communication backbone in system (PLCs, managed switches, protocol converters, communication cards on final field devices, radios, etc.), list firmware revision, vendor and local distributor information, and system, warranty information, configuration parameters (e.g., communication settings, fail position settings, etc.)
 3. Panel wire pull tests shall be performed to ensure all wiring has been connected with appropriate torque to prevent wires from coming loose.
 4. All control panel circuitry shall be tested for correct function and conformance to shop drawings.
 5. UPS shall be tested to verify UPS switch power correctly while keeping all UPS powered loads online. Testing of UPS to determine if they have been sized correctly to maintain specified run time shall be performed during field testing.
 6. A 100 percent I/O point checkout shall be performed to verify proper operation of input/output points from panel terminations to HMI and OIT nodes. At a minimum, I/O checkout shall consist of four steps.

- a. Discrete input signals shall be jumpered at field terminal blocks in control panels to verify proper status in HMI and OIT nodes.
 - b. Analog input signals shall be connected to a signal generator at field terminal blocks in control panels to verify proper status in HMI and OIT nodes and signals shall be verified at zero percent, 50 percent, and 100 percent of full scale.
 - c. Discrete output signals shall be tested by switching equipment to manual control at HMI and OIT nodes and turning the output on or other means to turn the output on. Then verify the output is on by connecting a digital multimeter to measure continuity at terminations, thus verifying command from PLC has properly executed contact closure.
 - d. Analog output signals shall be tested by switching the equipment to manual control at HMI and OIT nodes and turning output on or other means to turn the output on. Then verify output by utilizing a digital multimeter to measure current or voltage generated at termination points.
7. For each hardware enclosure, inspection shall include, but not be limited to, cabinet enclosures, frame structure, paint work and finish, dimensions, and hardware operability (i.e., fans, door hinges, keylocks, etc.).
 8. For each subpanel, inspection shall include, but not be limited to, I/O subsystem physical layout, power supply sizing and mounting, cable routing, wire runs across hinges properly installed, fans and blowers unobstructed and mounted to maximize air flow, power conditioning correctly installed, and overall layout and installation of components meets manufacturer's recommendations and standard industry accepted practices.
 9. Demonstrate basic functionality of the operator interface terminal (OIT).
 10. Demonstrate network communication among the PLC, all Remote I/O racks, and other devices being furnished.
 11. Demonstrate all system software functions specified, including clock synchronization.
 12. Test system recovery from failure scenarios including cold boot, warm boot, communication loss, power failure, etc.

3.3 FIELD TESTING - OPERATIONAL READINESS TEST (ORT)

- A. The purpose of the ORT is to check that process equipment, instrument installation, instrument calibration, instrument configuration, field wiring, control panels, and all other related system components are ready to monitor and control the processes. This test will determine if equipment is ready for operation.
- B. The following tests shall be performed as part of ORT:
 1. Instrument calibration, configuration, and set-up.
 2. Input/Output (I/O) Testing to HMI and OITs.
 3. Testing of control strategies.

These inspections, calibrations, and tests do not require witnessing. However, Engineer may review and spot-check testing process periodically. All deficiencies found shall be corrected by PCSS prior to the ORT being considered complete.

C. Instrument calibration, configuration, and set-up:

1. Calibrate, configure, and set-up all components and instruments to perform specified functions.
2. Calibration form:
 - a. For any component or instrument requiring dip switch settings, calibration, or custom configuration, maintain a calibration form in field documenting this information. These forms shall provide a summary of the actual settings used in the field to allow an Instrument technician to replace the device entirely and configure it to function as it did before.
 - b. This information shall be added to Instrument data sheet, shall be added to a copy of manufacturer's standard "Configuration Sheet", or a separate form shall be created.
 - 1) If a separate form, the form shall list Project Name, Loop Number, ISA Tag Number, I/O Module Address, Manufacturer, Model Number/Serial Number, Output Range and Calibrated Value.
 - c. Some examples of required information are:
 - 1) For Discrete Devices: Actual trip points and reset points.
 - 2) For Instruments: Any configuration or calibration settings entered into instrument
 - 3) For Controllers: Mode settings (PID).
 - 4) For I/O Modules: Dip switch settings, module configuration (if not documented in native programming documentation).
 - d. Maintain a copy of these forms in field during testing and make them available for inspection at any time.
 - e. For any device that allows a software back-up of configuration files to a laptop, make configuration files available to Engineer/Owner for inspection. Submit as part of Final System Documentation as specified in Section [40 90 00] [13300].

D. I/O Testing:

1. Purpose of I/O testing is to check that process equipment, instrument installation, calibration, configuration, field wiring, and control panels are set-up correctly to monitor and control the processes. This test is commonly referred to as a "loop test" or an I/O checkout.
2. PCSS in conjunction with Contractor shall test signals under process conditions. Preferred test method will always be to execute test wherever possible to end elements. For example, preferred test will prove valve open/close limit switches by operating valve, not by installing a jumper on limit switch contacts. However, if equipment or process is not available to test a signal over its entire calibrated range, PCSS may test using a simulation method and make a note on sign-off form.
3. The following I/O tests shall be performed:
 - a. Discrete Input: At device or instrument, change signal condition from inactive to active state. Observe results on all indicators within loop such as HMI screens, OIT screens, pilot lights, horns, beacons, etc.

- b. Analog Input: Test analog signal over entire engineering range at various intervals including 0, 50%, and 100% as well as on increasing and decreasing range. Observe results on all indicators within loop such as HMI screens, OIT screens, recorders, digital indicators, etc.
 - c. Discrete output signals shall be tested by switching equipment to manual control at the HMI and OIT nodes and turning output on or using other means to turn output on. Then verify equipment responds accordingly.
 - d. Analog output signals shall be tested by switching equipment to manual control at HMI and OIT nodes and turning output on or other means to turn output on. Then verify equipment responds accordingly.
- E. The UPS shall be tested to verify UPS switch power correctly while keeping all UPS powered loads online. Also, test sizing of UPS by switching off line power to UPS and verify if they maintain specified run time.
- F. Upon successful completion of ORT, PCSS shall submit a record copy of test results as specified herein.

3.4 FIELD TESTING - SITE ACCEPTANCE TEST (SAT)

- A. After completion of the Operational Readiness Test, the OWNER will install self-developed PLC, OIT and HMI programming. The OWNER will notify the PCSS in writing of the start and end dates of their installation activities, not to exceed 30 calendar days. This period constitutes the Site Acceptance Test.
- B. During this time, PCSS personnel shall be present as required to address any potential issues with equipment furnished under the PCSS's scope of supply. The PCSS shall provide contact information for OWNER personnel to use to ensure that support staff are available by phone and/or on-site within four hours of a request by operations staff.
- C. While this test is proceeding, the Owner shall have full use of system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain responsibility of Owner and decision of plant operators regarding plant operations shall be final.
- D. Any malfunction during test shall be analyzed and corrections made by PCSS where applicable. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test. In event of rejection of any part or function that was furnished by PCSS, PCSS shall perform repairs or replacement within 5 days.
- E. Upon successful completion of the 30-day operation test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the warranty period shall commence.

END OF SECTION 406121

SECTION 406196 - PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Section 406100.

1.2 SUMMARY

- A. This Section is provided to clarify the control strategies to be used to program the system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. The control descriptions are broken into a hierarchical layer concept. There may be one layer or multiple layers per loop, depending upon that loop. An example of multiple layered loop is as follows. The lowest layer of control, local control, is at that piece of equipment or that piece of equipment's panel or drive. The second layer of control is at an intermediate control panel between the equipment and the SCADA I/O or vendor's PLC I/O. The third layer would be at the vendor's PLC or microprocessor touchscreen station. The highest layer of control is by the SCADA PLC System with its associated operator workstations (OWS) in the main control room, remote office locations, and satellite locations operator interface terminals (OITs). The SCADA PLC/ OWS refers to both the SCADA PLC, which does the actual monitoring and control logic for the process equipment and the SCADA operator workstation (OWS), which are computers that have graphical software that interface to the PLC software for monitoring and implementing all operator-required tasks to control that process equipment. Any functions done in the operator workstations also take place at all the SCADA OITs.

3.2 CONTROL FUNCTION DEFINITIONS AND GENERAL CRITERIA

- A. The hardware and/or software functions noted by this paragraph reference are to be implemented by the SCADA PLC/OWS control system specified herein.
- B. Refer to Drawing I-1, Instrumentation Legend, for the abbreviations utilized for control functions.

- C. All interlocks that are represented, before the local operational descriptions, or are stated as hardwired interlocks, shall interlock all the controls locally and at the SCADA PLC/OWS or at the vendor PLCs. The SCADA PLC shall be programmed to shut down that equipment if that hardwired interlock is also wired to the SCADA PLC.
- D. All interlocks that are represented in a particular layer of the operational descriptions, shall interlock all the controls in that layer and the layer after it. However, the interlock shall not interlock the commands in the layer before it.
- E. The SCADA system shall stop a motor or drive in its program if it does not receive the auto or remote status or one of its software interlocks trip. If the drive or motor is in hand or remote it will continue to run but the SCADA start/stop output will be open.
- F. All motors that are requested to start by an operator or an automatic program shall alarm if the run confirm status for that motor does not activate within two seconds. If a motor stops by an interlock or stops without any operator or SCADA intervention, then that motor shall go into alarm. All motors that are stopped by a program or the operator shall not go into an alarm.
- G. All valves that are requested to open by an operator or an automatic program shall alarm if the open feedback status for that valve does not activate within ten seconds. All valves that are requested to close by an operator or an automatic program shall alarm if the close feedback status for that valve does not activate within ten seconds.
- H. Motors that have an H/O/A shall indicate to the operator that the pump is being run in the "Hand" position. A motor is being run in "Hand" when the "Auto" position is not true and the run confirm status is true. If not in "Auto" the SCADA PLC shall open up its output contact to stop (shutdown) the pump from SCADA.
- I. All motors shall be programmed so if a motor stops for any reason, it shall not be re-started automatically once the problem with the motor has been resolved. The start command on the OWS shall not be a maintained contact but a momentary command to the PLC. The run confirms of all motors shall seal in the control output to the motor once the momentary start command drops out. The run confirms shall be on a five second timer delay in that if the run confirm is not present after five seconds, the contact output to the motor from the PLC shall drop out. Thus, the only way a motor can be restarted after five seconds by the SCADA system is if the operator reinitiates the start command for that motor on the OWS or when that motor control at the OWS is placed in complete automatic mode and the SCADA computer through logic/interlocks requests the motor to run.
- J. Terminology associated with interlocks is as follows:
 - 1. When a contact or status is true, the SCADA computer will receive power to its input channel. The SCADA computer registers this as a binary bit of one.
 - 2. When a contact or status is false, the SCADA computer will receive no power (open circuit) to its input channel. The SCADA computer registers this as a binary bit of zero.
- K. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card, the following SCADA programming shall take place:
 - 1. Alarm the signal at any local OITs and in the HMI system.

2. If the analog signal is associated with a control loop or ratio control loop that loop shall go into manual.
 3. If the analog signal is used in a calculation, that calculation shall use the last good analog signal. The computer shall place the control loop in manual if using the calculation.
- L. Disable all alarms on analog inputs unless specifically called for in the drawings or specifications.
- M. All interlocks that shutdown (Stop a piece of equipment and prevent it from being restarted or moved) shall be shown on the faceplate pop-up graphic for that piece of equipment.
- N. The run confirms or on status of all motors and lamps shall be accumulated to calculate a run time status of the equipment on the HMI graphic. Each run time accumulation shall come with a reset button on the HMI screen.
- O. All flow indications shall be totalized. Do not totalize if the analog signal is outside the 4-20 mA range. Each flow totalization shall come with a reset button on the HMI screen. Do not totalize if the value of the flow input is less than 2% of the full range of the input.
- 3.3 INDIVIDUAL CONTROL DESCRIPTIONS AND CONTROL SEQUENCES – WILSON BLVD.
- A. Level Controls
1. The bubbler will be the primary level instrument used for pump control.
 2. The submersible will be the secondary level instrument used for pump control, and will immediately take over in the event that the bubbler fails, or if the bubbler and submersible diverge beyond a set limit.
 3. The float switches will be the tertiary level instrument used for pump control, and will immediately take over in the event that the bubbler and the submersible are both failed. Float switch controls shall be relay-based, bypassing PLC control. A high float shall call two pumps to start at full speed. A low float shall call all pumps to stop.
- B. Primary Operation
1. Pumps shall be designated as Lead, Lag, and Standby. The Lead pump designation will rotate by subsequent start or at a pre-set maximum time in the Lead position.
 2. The station Lead pump will be called for duty at the first set point. The Lead pump will briefly ramp up to 100 percent speed briefly to clear debris and then reduce speed to maintain a constant pre-set wetwell liquid level. At no time shall any pump operate at a lower Hz than the manufacturer's minimum allowable speed. As flow into the wetwell increases and the wetwell level begins to rise, the Lead pump will increase speed to maintain the constant wetwell level. If the Lead pump reaches 100 percent speed and the wetwell level continues to rise, the Lag pump will be called for duty, briefly ramping up to 100 percent speed to clear debris, and then both Lead and Lag pumps will match speed and adjust to maintain a constant wetwell level. The process will be similar for the Lag-2 pump.
 3. As flow decreases, the pumps will simultaneously reduce speed and turn off individually in reverse order, maintaining a constant wetwell liquid level.

4. If the flow and wetwell level decreases below the minimum pump speed capacity for one pump operation in the station, the pump will shut off.
5. If the Lead or Lag pump fails or does not respond to control when commanded, the Standby pump will assume its place in the sequence.

C. Recirculation

1. There will be two modes of operation, manual (semi-automatic) start on timer, and fully automatic start on timer. In either case, the following sequence will commence.
2. The motor operated PV to the wetwell will open, and the motor operated PV on the discharge of the designated pump will close. Then the pump designated for recirculation mixing service will run at a reduced (adjustable set point) speed (assume 50%). Recirculation mode operates until a preset timer runs down, at which point the pump stops, the recirc valve is closed, and the discharge valve is opened. Normal operation of the pump then resumes.
3. The recirc designated pump alternates between Pump 1 and Pump 3 so that each side of the long wetwell may be cleaned.

- D. Grease Ring Control. Include periodic full drawdown and small changes in level setpoint over time to prevent grease ring buildup.

3.4 INDIVIDUAL CONTROL DESCRIPTIONS AND CONTROL SEQUENCES – 118th STREET

A. Level Controls

1. The bubbler will be the primary level instrument used for pump control.
2. The submersible will be the secondary level instrument used for pump control, and will immediately take over in the event that the bubbler fails, or if the bubbler and submersible in a given wetwell diverge beyond a set limit.
3. Automatic control using the bubbler or the submersible shall use whichever of the two wet well level signals is higher, or the operator may manually select one or the other.
4. The float switches will be the tertiary level instrument used for pump control, and will immediately take over in the event that the bubbler and the submersible in a given wetwell are both failed. Float switch controls shall be relay-based, bypassing PLC control. A high float shall call one pump in the same wet well to start at full speed. A low float shall call both pumps in the same wet well to stop.

B. Primary Operation

1. Pumps shall be designated as Lead, Lag, Lag-2, and Standby. The Lead pump designation will rotate by subsequent start or at a pre-set maximum time in the Lead position.
2. The station Lead pump will be called for duty at the first set point. The Lead pump will briefly ramp up to 100 percent speed briefly to clear debris and then reduce speed to maintain a constant pre-set wetwell liquid level. At no time shall any pump operate at a lower Hz than the manufacturer's minimum allowable speed. As flow into the wetwell increases and the wetwell level begins to rise, the Lead pump will increase speed to maintain the constant wetwell level. If the Lead pump reaches 100 percent speed and the wetwell level continues to rise, the Lag pump will be called for duty, briefly ramping up to 100 percent speed to clear debris, and then both Lead and Lag pumps will match speed

and adjust to maintain a constant wetwell level. The process will be similar for the Lag-2 pump.

3. As flow decreases, the pumps will simultaneously reduce speed and turn off individually in reverse order, maintaining a constant wetwell liquid level.
4. If the flow and wetwell level decreases below the minimum pump speed capacity for one pump operation in the station, the pump will shut off.
5. If the Lead, Lag, or Lag-2 pump fails or does not respond to control when commanded, the Standby pump will assume its place in the sequence.

C. Recirculation

1. There will be two modes of operation, manual (semi-automatic) start on timer, and fully automatic start on timer. In either case, the following sequence will commence.
2. The motor operated PV to the wetwell that is not in operation (i.e., no primary pumps on in that wetwell) will open. Then the primary wastewater pump designated for recirculation mixing service will run at a reduced (adjustable set point) speed (assume 50%). Recirculation mode operates until a preset timer runs down, and then closes the motor operated valve and stops the designated pump.
3. As the Lead pump alternates into that wetwell, the pump designated for recirc switches to the recirc designated pump in the other wetwell.

- D. Grease Ring Control. Include periodic full drawdown and small changes in level setpoint over time to prevent grease ring buildup.

END OF SECTION 406196

SECTION 406263 - OPERATOR INTERFACE TERMINALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1. Section includes operator interface terminals for use with programmable logic controllers (PLCs).
- B. Related Requirements:
 - 1. Section 406100, Process Control and Enterprise Management Systems General Provisions for submittal requirements.
 - 2. Section 406343, Programmable Logic Controllers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.
- B. Shop Drawings:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. None Required.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.7 FIELD CONDITIONS

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.8 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 OPERATOR INTERFACE TERMINAL (OIT)

- A. Manufacturers:
 - 1. Manufacturers and their products are subject to compliance with requirements. Provide the following:
 - a. Siemens – SIMATIC TP1500.
 - b. Substitutions: Not Permitted.
- B. General
 - 1. OITs are standalone devices with an integrated hardware / software platform to monitor / control a process through an interactive display.
- C. Features
 - 1. Software
 - a. OITs shall be pre-packaged with all configuration and programming software necessary to perform functions as shown on drawings and within the specifications.
 - b. Integrated OIT software shall have the following features:
 - Trending
 - Data logging
 - Alarms
 - Graphic symbols
 - Animations
 - 2. Hardware
 - a. Minimum one Secure Digital (SD) card slot

D. Communications

1. Ports

- a. Minimum two 10/100MB Ethernet
- b. Minimum one USB
- c. Minimum one serial RS-232

2. Protocols

- a. PROFINET

E. Display:

- 1. 15" viewable as measured across screen
- 2. Minimum display resolution: 1024 x 768
- 3. Color Active Matrix TFT.
- 4. Display shall support touch screen input.

F. Environmental:

- 1. Rating: OIT shall be rated to maintain the rating of the control panel it will be mounted on and meet the area classification.
- 2. Temperature: Operating temperature range of the OIT shall range 0 - 50 °C.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Sections 406717 and 406733.

END OF SECTION 406263

SECTION 406343 - PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1. Section includes programmable logic controllers.
- B. Related Requirements:
 - 1. Section 406100 "Process Control and Enterprise Management Systems General Provisions" for submittal requirements.

1.3 DEFINITIONS

- A. AO – Analog Output
- B. AI – Analog Input
- C. DI - Digital Input
- D. DO - Digital Output
- E. I/O – Input/Output
- F. PLC - Programmable Logic Controller

1.4 PREINSTALLATION MEETINGS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. Shop Drawings:

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. PLC CPU Module: One spare unit of each type installed.
2. PLC Power Supplies: One spare unit of each type installed.
3. PLC I/O Modules: Ten percent, minimum one, spare units of each type installed.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.9 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Configuration: Standalone programmable controller.

- B. Installed Spare Capacity :

1. Spare PLC I/O:
 - a. Provide 20 percent (minimum of four) points per type (AI, AO, DI, and DO) for future use.
 - b. If spare I/O points are supplied on empty modules, modules shall be of the same type and density as other I/O modules supplied.
2. Spare PLC Slots: Provide at least two spare slots in each chassis, or equivalent rail space, for addition of future I/O modules.

3. All installed spare points shall be wired out to terminal blocks and shall include surge protectors or interposing relays as required. Refer to Sections 406733, 407853, and 407856.

2.2 PLC SYSTEM

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide the following:
 - a. Siemens – S7-300 Series.
 - b. Substitutions: Not Permitted.

B. General:

1. Provide Programmable Logic Controller equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.
2. Provide processor, power supply, I/O modules, communication modules, redundancy modules, and remote interface modules as required to meet system requirements.
3. Provide products listed and classified by UL, CSA, or FM approval as suitable for purpose specified and indicated.
4. Provide products designed for continuous industrial service.
5. Provide products of a single manufacturer, insofar as possible
6. Provide equipment models that are currently in production.
7. Provide only equipment designed and constructed so that in the event of power interruption the systems go through an orderly shutdown with no loss of memory and resume normal operation without manual intervention when power is restored.
8. Provide PLCs that communicate between workstations, servers, instruments, switches, controllers, process actuators, etc. as shown on the Drawings and specified herein.
9. Provide products such that communication protocols shall be transparent from any HMIs or OITs.
10. Provide a PLC capable of stand-alone operation in the event of failure of the communication link to the HMI subsystem.
11. Provide I/O modules, interface modules, communication modules, and power supply to meet system I/O requirements.
12. Provide a PLC system that meets the following agency and environmental specifications:
 - a. Electrical supply voltage to the PLC: 120VAC, ± 15 percent, 48 - 63Hz. PLC system power supplies shall be fused for overload protection.
 - b. Vibration: 3.5 mm Peak-to-Peak, 5 - 9 Hz: 1.0G, 9 - 150Hz. The method of testing is to be based upon IEC 68-2-6 and JIS C 0911 standards for vibration. The system is to be operational during and after testing. Vibration Rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:
 - 1) Installed rating: DIN rail mounted PLC: 10 - 57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz.
 - 2) Panel or plate mounted PLC: 2 - 25 Hz, amplitude 1.6mm, acceleration 25 - 200 Hz.

- 3) In compliance with IEC 60068 and IEC 61131.
 - c. Shock: 15G, 11 msec. Method of testing is to be based upon IEC 68-2-27 and JIS C 0912 standards for shock. The system is to be operational during and after testing.
 - d. Temperature: All PLC hardware shall operate at an ambient temperature of 0° to 60° C (32° to 140° F), with an storage ambient temperature rating of -25° to 70° C (-40° to 185° F).
 - e. Relative Humidity: Programmable Controller hardware shall function continuously in the relative humidity range of 10 percent to 95 percent non-condensing.
 - f. Noise Immunity: Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.
 - g. Altitude:
 - 1) Operation: 0 - 6,500 feet.
 - 2) Storage: 0 - 9,800 feet.
 - h. Degree of protection: NEMA 1 (IP20).
 - i. All products shall have corrosion protection.
- C. Identify all major assemblies and sub-assemblies, circuit boards, and devices using permanent labels or markings indicating:
 1. Module product type such as analog or digital.
 2. Module catalog number.
 3. Module major revision number.
 4. Module minor revision number.
 5. Module manufacturer vendor.
 6. Module serial number.
- D. Include all necessary cables as specified by the manufacturer. Assemble and install cables per manufacturer recommendations.
- E. PLC CPU:
 1. CPU shall be, at a minimum, a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.
 2. CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers, and service special function modules every scan. The CPU shall process the I/O with user program(s) stored in memory, then control the outputs based on the results of the logic operation.
 3. Supply the CPU with a battery-backed time of day clock and calendar.
 4. CPU family shall allow for user program transportability from one CPU model to another.

F. Diagnostics:

1. Perform on-line diagnostics that monitor the internal operation of the PLC. If a failure is detected, initiate orderly system shutdown and fail-over. Monitor the following, at a minimum: Memory failure, memory battery low, and general fault, communications port failure, scan time over run, I/O failure, and analog or special function I/O module failure.
2. Make diagnostic information accessible to the host communications interfaces and to the PLC program.
3. PLC shall have indicators and on-board status area to indicate the following conditions:
 - a. CPU run.
 - b. CPU error or fault.
 - c. I/O failure or configuration fault.
 - d. Status of Battery or back-up power module.
 - e. Communications indicator.

G. Memory:

1. Provide non-volatile battery backed memory of type CMOS RAM program memory or equivalent.
2. Memory Backup System: Provide lithium battery backup or equivalent capable of retaining all memory for a minimum of three months and a Flash memory system capable of reloading program in the event of memory loss.
 - a. Backup Storage: Provide backup battery or capable of being replaced without disrupting memory integrity. Provide a visual indication of low battery voltage or module error and an alarm bit in the PLC program.
 - b. SD Memory Card: Provide memory card storage with capacity greater than processor memory capacity. Install memory cards in processors for factory testing.
3. Operating system shall be contained in non-volatile firmware. The memory containing the operating system shall be field updateable via a separate update tool.

H. Programming Environment:

1. Programming port: Use PLC Ethernet port for programming.
2. On-Line programming: Application programs may be modified or stored while the CPU is running, with minimal impact on the scan time.
3. Online programming including runtime editing.
4. IEC 61131-3 programming languages supported: Ladder logic, function block, sequential function chart, and structured text.
5. Supply all hardware and software necessary to program the CPU in these languages.

I. Communication Ports:

1. Provide expandable CPU supplied with additional modules to support the required communication interfaces.

J. Remote I/O Communications:

1. Provide CPU capable of communicating with up to 12 remote base locations. Automatically sample and update all local and remote I/O modules each scan cycle of the CPU.
2. Provide communication link between the CPU and any RIO chassis as recommended by the PLC manufacturer.
3. Provide diagnostic and equipment status information from each RIO.
4. Provide remote I/O system with a remote input/output arrangement capable of operation at locations physically separated from the PLC CPU as detailed on the drawings.
5. Communicate with the remote I/O arrangement through cable as recommended by the PLC manufacturer and provided by the PLC system supplier under this specification Section.

K. Power Supplies:

1. Power Input: 85 to 265VAC, 47 - 63Hz.
 - a. Provide DC power supplies capable of handling ripple up to 2.4V peak to peak.
2. Provide chassis mounted power supplies to power the chassis backplane and provide power for the processor and applicable modules.
3. Provide clearly visible LED to indicate that the incoming power is acceptable, and the output voltage is present.
4. Provide over-current and over-voltage protection designed to operate in most industrial environments without the need for isolation transformers.
5. Size power supplies to accommodate the nominal load plus 30%.
6. Provide power supplies capable of sustaining brown out conditions of at least 1/2 of a cycle, a harmonic rate of 10%, and continuous operation through momentary interruptions of AC line voltage of 10ms or less.
7. Automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power.
8. Provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line.

L. Discrete Input & Output Modules:

1. General:
 - a. Provide digital input and output modules to provide ON/OFF detection and actuation capability.
 - b. Provide cards of I/O type and count as required to implement the functions specified plus an allowance for active spares, as noted below.
 - c. Provide modules capable of being installed or removed while chassis power is applied.
 - d. Provide the following status indicators.
 - 1) On/Off state of the field device.
 - 2) Module's communication status.
 - 3) Module health
2. Module Specifications – 120VAC Input Module

- a. Nominal Input Voltage: 120VAC
- b. On-State Current: 15mA @132V AC, 47 - 63Hz maximum.
- c. Maximum Off-State Voltage: 20V.
- d. Maximum Off-State Current: 2.5mA.
- e. Number of Points per Card: 16.

3. Module Specification – 120 VAC Solid State Output Module

- a. For each triac type discrete output, provide an associated interposing relay located in the same control panel. Provide 120 VAC power for relay outputs from the associated motor starter control circuit (when used with motor starters) or other 120 VAC source (when I/O is not associated with a particular motor starter).
- b. Output Voltage Range: 74 - 265 VAC, 47 - 63 Hz.
- c. Output Current Rating:
 - 1) Per Point: 0.5A maximum @ 30 degrees C; 0.25A maximum @ 60 degrees C; Linear Derating.
 - 2) Per Module: 4A maximum @ 30 degrees C; 2A maximum @ 60 degrees C; Linear Derating.
- d. Surge Current per Point: 5A for 43ms each, repeatable every 2s @ 60 degrees C.
- e. Minimum Load Current: 10mA per point.
- f. Maximum On-State Voltage Drop: 1.5V peak @ 2.0A and 6V peak @ load less than 50mA.
- g. Maximum Off-State Leakage: 2.5mA per point.
- h. Number of Points per Card: 16.

4. Module Specifications – Individually Isolated Relay Output Module

- a. Output Voltage Range: 10 - 265 VAC, 47 - 63 Hz, 5 - 125 VDC.
- b. Output Current Rating:
 - 1) Per Point: 2.5A maximum.
 - 2) Per Module: 16A maximum.
- c. Power Rating (Steady State): 250 VA maximum for 125 VAC inductive output.
- d. Maximum Off-State Leakage: 0 mA per point.
- e. Configurable States:
 - 1) Fault per Point: Hold Last State, ON or OFF.
 - 2) Program Mode per Point: Hold Last State, ON or OFF.
- f. Number of Points per Card: 16.

M. Analog Input & Output Modules:

1. General:

- a. Provide analog input modules to convert an analog signal that is connected to the module's screw terminals into a digital value. The digital value representing the magnitude of the analog signal shall be transmitted on the backplane. Provide

analog output modules to convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals.

- b. Provide modules designed to be installed or removed while chassis power is applied.
- c. Provide indicators to display the status of communication, module health and input / output devices.
- d. Provide both hardware and software indication when a module fault has occurred. Each module shall have an LED fault indicator and the programming software shall display the fault information.
- e. Provide analog modules that are software configurable through the I/O configuration portion of the programming software.
- f. Following status shall be capable of being examined in ladder logic:
 - 1) Module Fault Word: Provides fault summary reporting.
 - 2) Channel Fault Word: Provides under-range, over-range and communications fault reporting.
 - 3) Channel Status Words: Provides individual channel under-range and over-range fault reporting for process alarm, rate alarms and calibration faults.
- g. Provide 24 VDC power for analog instrument loops as a part of the system. Derive 24 VDC power supply from the 120 VAC input power circuit to the PLC. Group the field side of the 24 VDC power sources(s) as individual or grouped (of logically associated circuits) fusing and provide with a readily visible, labeled blown fuse indicator.

2. Differential Analog Input Module:

- a. Input Range: 0-20 mA.
- b. Resolution: approximately 16 bits across range.
- c. Input Impedance: Greater than 249 Ohms.
- d. Overvoltage Protection: 8V ac/dc with on-board current resistor.
- e. Normal Mode Rejection: 60 dB at 60 Hz.
- f. Common Mode Noise Rejection: 120 dB at 60 Hz, 100 dB at 50 Hz.
- g. Isolation Voltage:
 - 1) Channel to Ground/Chassis - 100% tested at 1000 VDC minimum for 1s based on 250 VAC.
- h. Number of Points per Card: 8.

3. Isolated Analog Output Current Module:

- a. Output Current Range: 4 to 20 mA.
- b. Current Resolution: 12 bits across 20 mA.
- c. Open Circuit Detection: None.
- d. Output Overvoltage Protection: 24V ac/dc maximum.
- e. Output Short Circuit Protection: 20 mA or less (electronically limited).
- f. Calibration Accuracy: Better than 0.1% of range from 4 mA to 20 mA.
- g. Number of Points per Card: 8.

N. Communications Interfaces:

1. Supported protocols:
 - a. PROFINET.
 - b. PROFIBUS DP.
2. Ports:
 - a. 100MB/1G Ethernet.
 - b. RS-485 Serial.

2.3 PLC SOFTWARE

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide the following:
 - a. As required to match supplied PLCs.
 - b. Substitutions: Not Permitted.

B. Provide a PLC configuration and application development software package complete with documentation and installation media. The PLC software package and associated licensing and/or activation shall be installed on the computers shown on the Drawings.

C. Allow on-line/off-line program development, annotation, monitoring, debugging, uploading, and downloading of programs to the PLCs.

D. Provide all required hardware (including cables, cable adapters, etc.) for connection to PLCs.

E. Provide all software licenses required to achieve the functionality described in the Specifications.

F. Include a software license agreement allowing the Owner the right to use the software as required for any current or future modification, documentation, or development of the PLCs provided for this project.

G. Provide software capable of the following IEC 61131-3 functions:

1. Ladder logic.
2. Function block.
3. Sequential function chart.
4. Structured text.

H. In addition to the above editors, an add-on instruction editor shall work with any of the above-mentioned editors to create custom reusable function blocks. This software shall allow any of the derived function blocks to be modified on-line.

I. Software shall be Microsoft Windows-based and run on the supplied computers.

- J. Software shall include a security feature to prevent unauthorized personnel from modifying and downloading the programs.
- K. Provide an I/O simulator which allows the PLC application load program to be tested on a PC with simulated analog and digital inputs and outputs, allowing I/O testing and debugging to be performed in a safe, isolated environment without the need for running the PLC CPU and process I/O boards.

PART 3 - EXECUTION

3.1 PANEL LAYOUT

- A. Coordinate size and configuration of enclosure to meet project requirements.
- B. Comply with clearance dimensions and wire sizes recommended by PLC manufacturer. Doors on all components shall be able to be fully closed when all the wires are installed. No wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack. PLC status lights, keyholes, communication ports, and memory card slots shall not be blocked at any time.
 - 1. Provide additional clearance on each side of each PLC component beyond what is recommended by the PLC manufacturer to allow for a possible future upgrade to Siemens S7-1500 series equipment. Provide an additional one inch of height above and below (height), and one inch in front of (depth), each PLC rack. Provide an additional three inches of width on either side of each PLC rack.
- C. Control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements.
- D. All analog, discrete, and communication signals shall be protected from surge and interference as prescribed in Section 407856.
- E. All PLC equipment shall be powered from the UPS power conditioning system in Section 406763.
- F. Where multiple mechanical components are provided for process redundancy, their field connections to I/O modules shall be arranged such that the failure of a single module will not disable all mechanical components associated with the process redundancy (e.g., inputs and outputs for redundancy device 1 shall reside on different modules than the inputs and outputs for redundancy device 2, etc.), irrespective of the number of used points resulting from this configuration.
- G. Provide all required cables, cords, and connective devices for interface with other control system components.

3.2 INSTALLATION

- A. Comply with NECA 1.

- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

- A. Refer to Section 406717 for tagging requirements.

END OF SECTION 406343

SECTION 406613 - SWITCHES AND ROUTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1. Section includes switches and routers.
- B. Related Requirements:
 - 1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.
- B. Shop Drawings:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. None Required

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.7 FIELD CONDITIONS

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.8 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 RACK-MOUNTABLE MANAGED ETHERNET SWITCH

- A. Manufacturers:
 - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Allen-Bradley: Stratix 5410 series.
 - b. Cisco: Catalyst 3850 series.
 - c. Moxa: 7000 series.
 - d. Substitutions: Or equal.
- B. General:
 - 1. Furnish a modular, rack-mountable, managed Ethernet switch for connection to the network as shown in the Drawings and specified herein.
 - 2. Furnish switches by the same manufacturer for the project, regardless of type.
- C. Physical Features:
 - 1. Modular 19-inch rack-mountable enclosure.
 - 2. Furnish the number of ports of each type necessary to make the connections shown on the Drawings, plus a minimum of 25 percent spare of each type. This shall include 1G/10G SFP slots for addition of fiber or copper ports, 1G Power-over-Ethernet (PoE) copper ports, and 100M/1G copper ports.
 - 3. Modular construction such that additional copper and fiber ports can be added and removed.
 - 4. Operating temperature: 0 to 130 °F.
 - 5. Power: 120VAC redundant power supplies.
 - 6. Enclosure: Metal case.
 - 7. Rating: UL Class 1, Division 2 Groups A, B, C, and D.
- D. Network Features:
 - 1. Layer 3 routing.
 - 2. Spanning Tree Protocol (STP)
 - 3. Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1w)
 - 4. Full duplex on all port.
 - 5. Auto negotiation and manual configurable speed and duplex.

6. Wire speed switching fabric.
7. IGMP snooping.
8. IGMP filtering.
9. Configuration password protected.
10. Configuration backup capability required.
11. SNMP V3.
12. Lock port function for blocking unauthorized access based on MAC address.

E. Additional Features:

1. Provide a dry contact rated for 120 VAC 5A to be used for common trouble alarm. The alarm shall be programmable. If the contact cannot use 120 VAC 5A, provide the necessary 24 VDC power from the PLC panel and provide interposing relays in the PLC panel.

2.2 PROFIBUS NETWORKING

- A. Provide one or more multi-channel repeaters for the integration of PROFIBUS DP devices into reliable star/tree networks and connection of them to the SCADA PLC. Furnish Procentec ProfiHub series, no substitutions, exact model as required to suit the requirements reflected on the Drawings.

B. PROFIBUS DP Cable

1. Where required, provide shielded twisted pair cable designed for use with a PROFIBUS DP network. The twisted pair cable shall be non-plenum, with one 22AWG solid copper conductor pair, a tinned copper braid shield, and sunlight resistant PVC jacket. The cable shall have nominal impedance of 150 ± 15 ohms at 3-20MHz, and maximum attenuation of 5.4dB per 100m at 16MHz. All RS485 bus connector terminations shall be done in a professional and workmanlike manner and shall provide for proper shield grounding and strain relief.
2. Cable shall be Siemens Fast Connect type 6XV1830-0EH10 or approved equal. Connectors shall be Brad Harrison MA9D00-42 and MA9D01-42 type or approved equal.

C. Serial Cable

1. Where required, provide DB9 serial RS232 patch cables, with connectors suitable for industrial environments.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.2 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. For Managed Ethernet Switches:
 - a. Enable the lock port function to block unauthorized access based on MAC address for each switch and router. All devices connecting to switch shall have static IP addresses assigned.
 - b. Lock down all spare switch and router ports.

END OF SECTION 406613

SECTION 406717 – INDUSTRIAL ENCLOSURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes components and construction requirements for SCADA control panels and network racks.
- B. Related Requirements:
 - 1. Section 406733, Panel Wiring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 WARRANTY

- A. Refer to Section 406100.
- B. The PCSS shall supply a three (3) year minimum unconditional warranty after completion or acceptance of the panel on all parts supplied by the PCSS, excluding parts supplied by the Owner. The warranty shall include materials and installation, and shall constitute complete replacement and delivery to the site of materials and installation of same to replace defective material or defective workmanship with new materials/workmanship conforming to the specifications.
- C. The PCSS shall also be responsible to ensure that warranties provided by component manufacturers that exceed the PCSS's warranty are honored.

PART 2 - PRODUCTS

2.1 LIGHTNING/SURGE PROTECTION

- A. Refer to Section 407856.

2.2 CONTROL PANEL GENERAL REQUIREMENTS

- A. The dimensions within this Section and on the Contract Drawings are for general reference only. Ensure that final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as specified herein and in the Contract Documents.
 - 1. Refer to Section 406343 for panel layout requirements related to programmable logic controllers (PLCs).
- B. Each control panel and terminal cabinet shall bear the UL label. The UL label shall apply to the enclosure, the specific equipment supplied with the enclosure, and the installation and wiring of the equipment within and on the enclosure.
 - 1. Attach a UL 508A serialized label "Enclosed Industrial Control Panel". The use of the label "Industrial Control Panel Enclosure" without the UL508A serialized label shall not be acceptable.
 - 2. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and any other equipment necessary to achieve compliance with UL 508A requirement. The Drawings do not detail all UL 508A requirements.
- C. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.
- D. The devices designated for rear-of-panel mounting shall be arranged within the panel according to respective panel drawings and in a manner to allow for ease of maintenance and adjustment. Heat generating devices such as power supplies shall be located at or near the top of the panel.
- E. All components shall be mounted in a manner that shall permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with manufacturer's recommendations. The internal components shall be identified with suitable plastic or metal engraved nametags mounted adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and ISS's data.
- F. All hardware and fasteners shall be 316 stainless steel. All mounting screws shall be drilled and tapped; self-tapping screws are not permitted.
- G. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.

H. Nameplates

1. All panels and panel devices shall be supplied with suitable nameplates, which identify the panel and individual devices as required. Unless otherwise indicated, each device nameplate shall include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).
2. Nameplates shall be 3/32-inch thick, plastic laminate with engraved inscriptions. The letters shall be White against a Black background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.
3. Nameplate fasteners and mounting shall be epoxy adhesive or stainless steel screws.
4. For every panel, provide a main panel nameplate with a minimum of 1" high letters. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights, and meters.
5. Single lamicoid nameplates with multiple legends shall be used for grouping of devices such as selector switches and pilot lights that relate to one function.

I. Mounting Elevations

1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.
2. Centerline of indicators and controllers shall be located no lower than 48-inches or higher than 66-inches above the floor on a panel face.
3. Centerline of lights, selector switches, and pushbuttons shall be located no lower than 32-inches or higher than 70-inches above the floor on a panel face.
4. Tops of annunciators shall be located no higher than 86-inches above the floor on a panel face.
5. Installation of panel components shall conform to component manufacturers' guidelines.

2.3 CONTROL PANEL ENCLOSURES

A. Manufacturers

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. nVent: Hoffman.
 - b. Rittal.
 - c. Saginaw.
 - d. Substitutions: Or equal.

- B. All panels in indoor, dry, non-corrosive environments shall be NEMA 12 unless otherwise noted, and shall be of steel construction. All panels in outdoor, wet, or chemically corrosive environments shall be NEMA 4X and of 316 stainless steel construction. All panels located in a hazardous location shall be rated for the type of hazard (e.g., NEMA 7 for Class 1, Division 1).

- C. Provide angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be supplied with a structural framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation.
- D. Each panel shall be provided with full height, fully gasketed access doors. Doors shall be provided with a three-point stainless steel latch and heavy duty stainless steel locking handle. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments. Clamp-type door latches are not permitted.
- E. The panels, including component parts, shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.
- F. The panel shall be suitable for top and bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry, the panel top shall be provided with nominal one-foot square removable access plates, which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, and other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.
- G. Freestanding and Floor-Mounted Vertical Panels. Freestanding and floor-mounted vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of 12-gauge sheet steel, suitably braced internally for structural rigidity and strength. All panels shall be constructed of 316 stainless steel. Front panels or panels containing instruments shall be not less than 10-gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.
- H. Wall and Unistrut Mounted Panels. All wall and Unistrut mounted panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of not less than USS 14-gauge steel, suitably braced internally for structural rigidity and strength. All wall mounted panels shall be constructed of 316 stainless steel.
- I. Finish Requirements (except for NEMA 7 rated enclosures)
 - 1. All sections shall be descaled, degreased, filled and ground, phosphate cleaned, and finished.
 - 2. Enclosure finish shall be polyester powder-coated. NEMA 12 indoor enclosure exterior shall be ANSI 61 gray. The exterior of outdoor panels and NEMA 4X panels shall be white. All sun shield panels shall be white. All enclosure interiors shall be white.
- J. When an Uninterruptible Power Supply (UPS) is to be located inside a freestanding or floor-mounted vertical panel, provide a shelf for the UPS located on the side wall of the panel away from other equipment. The shelf shall be constructed of not less than USS 14-gauge steel, suitably braced for structural rigidity and strength, and finished to match the interior panel color. The shelf shall be bolted to the enclosure, such that the NEMA rating of the panel is not compromised.

- K. Print storage pockets shall be provided on the inside of each panel. The storage pockets shall be constructed of compatible material with the panel door, welded onto the door, and finished to match the interior panel color. The storage pocket shall be sufficient to hold all of the prints required to service the equipment, and to accommodate 8.5 inch by 11 inch documents without folding.
- L. Corrosion Control. Panels shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Northern Technologies International Corporation, Model Zerust VC; Hoffman Model AHCI; or equal.

2.4 CONTROL PANEL ENVIRONMENTAL CONTROL

- A. Heat load calculations shall be submitted for all unvented control panels that are not located in air-conditioned areas. The internal temperature of all panels shall be regulated to minimum 5°C; maximum 40°C, or 5°C below the lowest rated component, whichever is greater; under all conditions.
- B. Heat calculations shall be conducted in accordance with “JEA Water & Wastewater Standards Manual” (rev. 1/1/2019), Section 433, paragraph VI.3.13.16, pages 20-22 of 49.
- C. Provide custom fabricated sun shields for all outdoor panels and instrument racks in accordance with the following requirements:
 - 1. Sun shields shall be fabricated from .125 Marine Grade Aluminum, powder-coated white on all surfaces. Units shall be designed, fabricated, installed, and supported to fully cover and shade the top, sides and back of the enclosure, and to partially shade the front panel of the enclosure, from direct exposure to sunlight from sunrise to sunset.
 - 2. Depending on overall size, sun shields may be fabricated in single or multiple segments for attachment to the enclosure support framing or to separate free-standing framing around the enclosure, to preserve rigidity.
 - 3. Sun shields shall not be attached directly to the enclosure by drilling holes through, or welding studs to, the enclosure surfaces, and shall be designed and mounted to provide a minimum 3-inch air gap all around the enclosure for air circulation and heat dissipation.
 - 4. The top section of all sun shields shall be sloped at a minimum angle of 5 degrees from horizontal. For wall mounted enclosures, the top section shall slope downward away from the wall and towards the front of the enclosure. For free standing, floor mounted and frame mounted enclosures the top section shall slope downward towards the back side of the enclosure.
 - 5. The front edge of the top section of all sun shields shall incorporate a narrow and more steeply sloped drip shield segment which sheds water away from the front of the enclosure and prevents it from dripping or running directly onto the front panel of the enclosure.
 - 6. All seam welds used in sun shield fabrication shall be continuous and shall be ground smooth.
 - 7. All exposed corners, edges and projections shall be smooth rounded or chamfered to prevent injury.
- D. Under no circumstances shall temperature control methods compromise the NEMA rating of the panel. Air conditioners are not allowed.

- E. All control panels that are located outdoors or in unconditioned indoor process areas shall be provided with an integral heater, fan, and adjustable thermostat to reduce condensation and maintain the minimum internal panel temperature. Mount the unit near the bottom of the enclosure with discharge away from heat-sensitive equipment. Heater shall be Hoffman DAH or equal.

2.5 INSTRUMENT RACKS

- A. Instrument racks shall be sized and configured to support all indicated instruments and accessories, such that they are easily accessible to operators. Mounting elevation requirements provided herein shall apply. Elements to be mounted on an instrument rack may include transmitters and controllers; sensor assemblies; sample and drain pipes, tubes, valves and manifolds; sample pumps or compressors; power supplies, surge suppressors and disconnects.
- B. Instrument rack plates shall be fabricated from .125 Marine Grade Aluminum, powder-coated white on all surfaces. Depending on overall size, racks may be fabricated in single or multiple segments for attachment to the support framing, to preserve rigidity. All exposed corners, edges, and other projections shall be smooth rounded or chamfered to prevent injury.
- C. Each instrument rack shall be securely attached by stainless steel hardware to two or more steel support struts. Struts shall be steel, no less than 1 inch square, permanently installed in concrete, coated in bitumastic paint up to 18 inches above the concrete for protection against moisture. All exposed corners, edges and protruding bolts shall be smooth rounded or capped to prevent injury.
- D. Instrument racks located outdoors shall have sun shields that fully shade all instrument displays.

2.6 19-INCH EQUIPMENT RACKS

- A. Description: Two post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.
- B. General Requirements:
 - 1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Material: Extruded steel.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
 - 4. Color: Black.
- C. Wall-Mounted Racks:
 - 1. Depth: 23 inches.
 - 2. Load Rating: 150 lb.
 - 3. Number of Rack Units per Rack: 12.
 - 4. Wall Attachment: Four mounting holes.
 - 5. Equipment Access: Integral swing.

D. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

E. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Six 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
7. Close-coupled, direct plug-in line cord.
8. Rocker-type on-off switch, illuminated when in on position.

F. Manufacturer. Kendall Howard "Phantom Class" 12U or 18U, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

C. Wiring within Enclosures:

1. Refer to Section 406733.
2. 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.

3.2 PANEL SCHEDULE

- A. Furnish the following panels and consoles:

Panel Designation	Minimum Panel Size	Maximum Space Available	Enclosure Rating & Type
118 th St Pump Station RTU Panel	n/a	36" W x 90" H x 24" D	NEMA 12, single door, free standing, front access only
118 th St Pump Station Network Rack	n/a	36" W x 90" H x 24" D	19 inch rack
Wilson Blvd Pump Station RTU Panel	n/a	36" W x 90" H x 24" D	NEMA 12, single door, free standing, front access only
Wilson Blvd Pump Station Network Rack	n/a	36" W x 90" H x 24" D	19 inch rack

END OF SECTION 406717

SECTION 406733 - PANEL WIRING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes requirements for internal wiring of control panels and consoles.
- B. Related Requirements:
 - 1. Section 406717, Industrial Enclosures.

1.3 ACTION SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 CONTROL PANEL - INTERNAL CONSTRUCTION

- A. Internal Electrical Wiring:
 - 1. Provide stranded, type MTW interconnecting wiring with 600 volt insulation rated for not less than 90 degrees Celsius. Segregate wiring for systems operating at voltages in excess of 120 VAC from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Develop panel layout such that technicians shall have complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.
 - 2. For power distribution wiring on the line side of fuses or breakers, use 12 AWG minimum. For control wiring on the secondary side of fuses, use 16 AWG minimum. Utilize 18 AWG shielded, twisted pair cable insulated for not less than 600 volts for electronic analog circuits. Control wiring shall be terminated with ferrules.
 - 3. Cover power distribution blocks with protective guards to meet “finger-safe” requirements of IP20.
 - 4. Route power and low voltage DC wiring systems in separate wireways. Cross different system wires at right angles. Separate different system wires routed parallel to each other by at least 6-inches. Terminate different wiring systems on separate terminal blocks. Do not fill wiring troughs to more than 60 percent visible fill.
 - 5. Terminations:

- a. Terminate all field wiring onto terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable.
 - b. Arrange terminal blocks in vertical rows and separated into groups (power, AC control, DC signal). Provide each group of terminal blocks with a minimum of 25 percent spares.
 - c. Terminal blocks shall be WAGO Top Job S series or approved equal. The minimum size shall be 4mm. The spring portion of the clamp shall be fabricated of a chrome nickel spring steel of high tensile strength and shall be solid, without perforation. The chrome nickel spring steel spring tension mechanism shall provide the installer the opportunity to directly insert solid or ferruled conductors without having to utilize tooling to open the clamping mechanism. The terminal block shall be designed to accept solid and/or stranded copper conductors without requiring special preparation, such as crimps, ferrules or tinning. Proportional clamping shall ensure mechanical and electrical connection integrity without damage to the conductors of various sizes throughout the rated range. The design of the terminal block shall not prevent or interfere with the use of wire preparation methods, such as crimps, ferrules or tinning. The pullout force shall be a minimum of 6 times that specified in VDE 0611 (Resistance to Vibration Test for Terminal Block). The current bar and clamping yoke shall have traverse grooves to increase the force required for conductor pull out and “Gas tight” connection. The voltage drop also shall remain virtually unchanged. Gas tightness will be per DIN 41640, part 76.
 - d. Use only one side of a terminal block row for internal wiring. Field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free-standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.
 - e. Use two terminals per point for discrete inputs and outputs (DI and DO) with adjacent terminal assignments. Wire all active and spare PLC and controller points to terminal blocks.
 - f. Use three terminals per point for analog inputs and outputs (AI and AO) per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. Wire all active and spare PLC and controller points to terminal blocks.
 - g. Use only one side of a terminal block row for internal wiring. Field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free-standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.
 - h. Control wiring shall be terminated with ferrules.
 - i. Use sleeve-type wire and tube markers with heat impressed letters and numbers. Provide Flattened Polyolefin Heat Shrink Markers for Permanent Wire and Cable Identification by Panduit, or approved equal. Note that Pass & Seymour “Legrande” is not an approved equal.
6. Isolate circuit power from the SCADA cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. One isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.

7. Isolate all PLC discrete outputs to the field with an isolating fuse switch terminal block with a flip cover and a neon blown fuse indicator.
 8. Clearly identify wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection as such.
 9. Internal panel wiring shall be clearly tagged and color coded. Tag numbers and color coding shall correspond to panel wiring diagrams and loop drawings prepared by the PCSS. Power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. Color coding scheme shall be in accordance with UL 508A.
 10. Provide surge protectors on all incoming power supply lines at each panel per requirements of Section 407856 – Isolators, Intrinsic Safety Barriers, and Surge Suppressors.
 11. Each field instrument furnished under Division 40 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication. Instruments requiring 120VAC power shall be powered as shown on the Drawings.
 12. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. Side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.
 13. Each panel shall have a single tube, LED light fixture, 20 Watt in size (minimum), mounted internally to the ceiling of the panel. Light fixture shall be switched and shall be complete with the lamp.
 14. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate cover. Convenience receptacle shall not be powered from a UPS and shall be protected by a dedicated fuse or circuit breaker.
 15. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.
 16. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
 17. Each panel shall have control, signal, and communication line surge suppression in accordance with Section 407856.
 18. Microprocessor-based electronic devices in the panel that are powered by 120VAC shall be powered by the UPS, refer 406763.
 19. Each panel shall be provided with a circuit breaker to interrupt incoming power.
 20. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 26.
- B. Relays not provided under Division 26 and required for properly completing the control function specified in Division 40, Division 26 or shown on the Drawings shall be provided under this Section.
- C. Orientation of devices including PLC and I/O when installed shall be per the manufacturer's recommendations. No vertical orientation of PLC racks shall be allowed unless specifically indicated by the manufacturer as an acceptable mounting alternative and also approved by the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. 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.

END OF SECTION 406733

SECTION 406763 - CONTROL PANEL MOUNTED UPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes control panel mounted uninterruptible power supply.
- B. Related Requirements:
 - 1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.
 - 2. Section 406717, Industrial Enclosures.
 - 3. Section 406733, Panel Wiring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.
- B. Shop Drawings:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 FIELD CONDITIONS

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.7 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 SINGLE-PHASE UPS - EXTERNAL TO CONTROL PANEL

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Eaton Powerware.
 - b. Emerson Liebert GXT3 Series.
 - c. Schneider Electric APC Smart-UPS.
 - d. Substitutions: Or equal.

B. System Description:

1. Provide a continuous-duty, on-line, solid state, dual conversion, single-phase input (using input voltage as shown on the Drawings), 120VAC input, single-phase 120VAC true sinewave output uninterruptible power system.
2. UPS shall provide power conditioning and power backup for computer, communication, and other critical electronic loads as indicated on Drawings.
3. UPS system shall consist of the following major components:
 - a. Rectifier and battery charger.
 - b. Inverter.
 - c. Batteries and battery disconnect switch.
 - d. Automatic static bypass switch.
 - e. External maintenance bypass switch, for units covering control panels.
 - f. Integral control and monitoring panel.
 - g. Other features as described in this Section and as indicated on Drawings.

C. General Requirements:

1. External Battery Enclosure: A separate enclosure shall be provided for housing additional batteries if required to provide minimum run time as specified herein. Battery enclosure shall match main UPS enclosure in style and color.
2. Cabling required to interconnect all components of UPS system shall be provided by UPS manufacturer.

3. Battery protection shall be provided an internal circuit breaker disconnect. Battery cabinets shall be protected by an internal circuit breaker.
4. Current limiting circuitry shall protect inverter output under any load condition. High speed semiconductor fusing shall protect static bypass in event of an output short circuit.
5. AC output neutral shall be electrically isolated from UPS chassis. UPS chassis shall have an equipment ground terminal. Provisions for installation of a bonding connector shall be provided.
6. UPS shall be suitable for installation at the location as shown on Drawings.

D. Performance Requirements - Ratings:

1. Battery runtime: Provide batteries to support 125% of calculated load for 20 minutes. Provide additional batteries in separate enclosure as required to meet runtime requirement.
2. Output power: Provide minimum recommended kVA ratings for the following UPSs in order to supply control panels and ancillary equipment shown on Control System Architecture Diagram and P&IDs. Confirm UPS ratings below per UPS submitted load calculations, spare capacity, and runtime requirements as specified herein.

E. Performance Requirements - Environment:

1. Ambient temperature: 0 to 40 degrees C.
2. Elevation: Project site elevation.
3. Relative humidity: 0 to 95 percent non-condensing.

F. Electrical Requirements:

1. System Input - Primary source:
2. Single input: Nominal Input Voltage: As shown on Drawings.
 - a. Frequency: 60 Hertz plus or minus five percent.
 - b. Input Power Factor: 0.96 lag minimum, 50 to 100 percent load.
 - c. Input Current Total Harmonic Distortion (THD): <33 percent.
 - d. Input Surge Withstandability: Per IEEE 587/ANSI C62.41. Category A and B, (6 kV).
 - e. Input Connection: Coordinate with electrical contractor.
3. System Output:
 - a. Nominal Output Voltage: As indicated herein and as shown on Drawings.
 - b. Frequency: 60 Hertz plus or minus 3 Hertz.
 - c. 100 percent load with 3:1 Crest Ratio.
 - d. Frequency Slew Rate: 1 Hz/second. (Adjustable at startup).
 - e. Output Connections: (six) NEMA 5-15R receptacles.
4. AC to AC Efficiency: (100 percent load @ rated PF): 91 percent.
5. Acoustical Noise: Noise generated by UPS under normal operation shall not exceed 65 dBA (60 dBA typical) at one meter from any surface, measured at 25 degrees C (77 degrees F) and full load.
6. EMI Suppression: UPS shall meet FCC Rules and Regulation 47, Part 15, Subpart B, for Class A devices.

G. Modes of Operation:

1. Normal Mode: UPS shall be a continuous online unit. Power to critical loads shall be continuously generated by inverter during normal AC line power. In event of AC line power failure, power to inverter is supplied by batteries. Under normal operation, batteries shall be charged in a manner that optimizes battery life. Simple "trickle charge" of batteries shall not be acceptable.
2. Bypass Mode: Automatic bypass shall transfer critical load to commercial AC source, bypassing UPS' inverter/rectifier, in case of an overload, load fault, or internal failure.
3. Maintenance Mode: If a Maintenance Bypass switch is provided, external manual bypass switch shall be operated to transfer load to alternate source when UPS is taken out of service for maintenance or repair. This transfer shall occur without interruption.

H. Controls:

1. Microprocessor-controlled circuitry: Fully automatic operation of UPS shall be provided through use of a microprocessor-based controller. All operating and protection parameters shall be firmware-controlled. Logic shall include system test capability to facilitate maintenance and troubleshooting. Startup, battery charging, and transfers shall be automatic functions.
2. Graphical Display: UPS control panel shall utilize an LED graphical display for all UPS control, monitoring, alarming, configuration and diagnostic functions. Following operational controls and indicators shall be provided on UPS control panel per following KVA ranges:

I. To 3 KVA Controls:

1. UPS On/Alarm Silence/Manual Battery Test control.
2. Standby/Manual Bypass control.

J. To 3 KVA Indicators:

1. LED Battery Meter.
2. Battery in operation status.
3. Load on Inverter status.
4. Load on By-Pass status.
5. AC input status.
6. UPS malfunction alarm.
7. 3 to 6 KVA Controls:
 - a. UPS On/Alarm Silence/Manual Battery Test control.
 - b. Off/ Bypass control.
8. Three to 6 KVA Indicators:
 - a. Battery in operation status.
 - b. Load on Inverter status.
 - c. Load on By-Pass status.
 - d. AC input status.
 - e. UPS malfunction alarm.
 - f. LED AC Input Meter.

- g. LED Battery Meter.
 - h. AC input voltage (line to line).
 - i. AC input current (each phase).
 - j. AC input power (kW, KVA and power factor).
 - k. DC battery voltage.
 - l. Battery current (charge and discharge).
 - m. AC output voltage (line to line and line to neutral).
 - n. AC output current (each phase).
 - o. AC output frequency.
 - p. AC output power (kW, KVA and power factor).
 - q. Diagnostic Alarms: Specific details for UPS alarms and status parameters shall be indicated on graphical panel for diagnosis.
- K. Remote alarm and status indication: Isolated SPDT Form C dry contacts shall be provided to indicate UPS status for remote monitoring. Contacts shall be rated for 250VAC @ 5A or 30VDC @ 5A. Individual contacts shall be provided for separate annunciation of the following alarm and status conditions:
- 1. UPS Normal (UPS is using utility power to power the load and detects no faults).
 - 2. UPS in Static bypass mode.
 - 3. UPS using battery to power the load.
 - 4. UPS on battery and battery low.
 - 5. If a maintenance bypass switch is provided, provide a contact from that switch to indicate UPS in Maintenance Bypass mode.
- L. Rectifier/Charger:
- 1. Term rectifier/charger shall denote solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to inverter and for battery charging. Rectifier/charger shall be a solid-state SCR/IGBT power transistor type with constant voltage/current limiting control circuitry.
- M. Inverter:
- 1. Inverter shall include all solid-state equipment and controls to convert DC power from rectifier/charger or battery to a regulated AC power for powering the critical load. Inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing specified AC output.
 - 2. Inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent. Inverter is to provide 150 percent of full load for 30 seconds and 125 percent of full load for 2 minutes. A status indicator and audible alarm shall indicate overload operation. UPS shall transfer the load to bypass when overload capacity is exceeded.
 - 3. Output voltage shall be maintained to within plus or minus 4 percent.
 - 4. Output voltage total harmonic distortion (THD) shall not be greater than 5 percent for all loads. For 100 percent rated load of 3:1 crest factor nonlinear loads, output voltage total harmonic distortion shall not be greater than 4 percent. Output rating shall not be derated in kVA or kW due to the 100 percent nonlinear load with 3:1 crest factor.
 - 5. Inverter shall use software control to adjust output voltage from plus or minus 5 percent of nominal value.

N. Batteries:

1. Batteries shall be VRLA (valve-regulated lead-acid), sealed, maintenance-free, high-rate discharge, lead-acid cells suitable for use indoors with no off-gassing or water addition requirements. Batteries shall not require special ventilation. Battery shall consist of one or more battery banks with number of cells required to meet requirements of the rest of these specifications.
2. Battery Design Life: five years.
3. Run time operation of UPS shall be accomplished using batteries mounted within UPS enclosure and supplemented as required with an external battery enclosure to provide battery runtime specified.

O. External Maintenance Bypass:

1. Each UPS covering a control panel shall be provided with a "two-position" external bypass switch system to permit UPS to be removed for repair or maintenance without causing power disruption to connected power loads. External bypass switch shall be snap-action type with switching speed approximately 10ms or less independent of operator action. External bypass switch positions shall be labeled UPS and UTILITY.
2. For UPS units up to and including 3KVA, furnish an Electrosch series 103 snap action switch or equivalent, along with custom plugs, receptacles, and appropriate wiring to achieve the specified functionality. For UPS units above 3 KVA, furnish standard manufacturer's maintenance bypass switch unless a dry contact for remote monitoring is specified herein to monitor the switch and it is not offered by the manufacturer. Otherwise, provide an Electrosch series 103 switch or equivalent along with custom plugs, receptacles, and appropriate wiring to achieve the specified functionality.
3. Provide a dry contact to indicate when bypass switch is in "Maintenance" position. Contact shall be rated for 250VAC @ 5A or 30VDC @ 5A.

P. Enclosures:

1. UPS equipment shall be housed in a free standing NEMA 1 enclosure(s). Enclosures shall line up and match in style and appearance.
2. Units to be mounted in 19-inch racks shall be provided in a matching form factor housing.
3. Units covering control panels shall be mounted in the side of the enclosure as described in Section 406717.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Sections 406717 and 406733.

END OF SECTION 406763

SECTION 407000 - INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Refer to Section 406100, Process Control and Enterprise Management Systems General Provisions.

1.2 SUMMARY

- A. Section includes the general requirements for furnishing, installing, and servicing PCSS provided instruments.
- B. Related Requirements:
 - 1. For Transit Time Ultrasonic Flowmeters, refer to Section 407166.
 - 2. For Float Switches, refer to "JEA Water & Wastewater Standards Manual" (rev. 1/1/2019), Section 433, paragraph VI.4.1, page 23 of 49.
 - 3. For Well Level Transducers, refer to "JEA Water & Wastewater Standards Manual" (rev. 1/1/2019), Section 433, paragraph VI.4.2, pages 23-24 of 49.

1.3 DEFINITIONS

- A. PCSS – Process Control System Supplier as defined in Section 406100 – Process Control and Enterprise Management System General Provisions

1.4 ACTION SUBMITTALS

- A. Submit complete documentation for all field instruments in one comprehensive submittal. Use ISA-TR20.00.01-2001 (updated in 2004-2006) data sheet format as a cover sheet for each instrument prior to data sheets. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment. The list shall be sorted by Loop Number.
- B. Submit separate data sheets for each instrument type including:
 - 1. Plant Equipment Number and ISA tag number per the Drawings.
 - 2. Product (item) name used herein and on the Drawings.
 - 3. Manufacturer's complete model number.
 - 4. Location of the device.
 - 5. Input - output characteristics.
 - 6. Range, size, and graduations in engineering units.

7. Include construction details, material descriptions, dimensions of individual components and profiles.
 8. Instrument or control device sizing calculations where applicable.
 9. Indicate which instruments will be provided with certified calibration data (i.e., all flow metering devices) as part of O&M manual.
 10. Include rated capacities, operating characteristics, electrical characteristics and furnished specialties and accessories Two-wire or four-wire device type as applicable.
 11. Indicate which instruments will be provided with manufacturer's maintenance services if specified.
- C. Submit manufacturer catalog cuts for all instruments. Submit descriptive literature for each hardware component which fully describes the units being provided.

1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding closeout submittals for instruments.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Refer to individual instrument specifications for spare parts requirements.
- B. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for PCSS requirements regarding submission of maintenance materials

1.7 QUALITY ASSURANCE

- A. Refer to individual instrument specifications for quality assurance requirements as well as which specific instruments require manufacturer's start-up and training services.
- B. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for overall quality assurance requirements for PCSS scope of work.

PART 2 - PRODUCTS

2.1 INSTRUMENT TAGS

- A. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section and related sections. Equipment shall be tagged before shipping to the site.
- B. Provide 1/8-in by 3/8-in, Type 316 stainless steel button head machine screws.
- C. All supplied instrument transmitters and instrument transmitter elements shall have a stainless steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via stainless steel chain or stainless steel wire (24 gauge min) to a non-removable part

of the device. The tag size shall be a minimum of 1”H x 3”W. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-in high alphanumeric characters.

PART 3 - EXECUTION

3.1 GENERAL

- A. See execution requirements in Section 406100 – Process Control and Enterprise Management Systems General Provisions.
- B. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, 5-valve manifolds for calibration, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

3.2 INSTALLATION

- A. See installation requirements in individual specification sections.

3.3 INSTRUMENT LIST

- A. Float Switches
 - 1. LSL-1021: 118th St Pump Station Wet Well No.1 Low Level (Tertiary)
 - a. Elevation: xx.xx’
 - 2. LSH-1021: 118th St Pump Station Wet Well No.1 High Level (Tertiary)
 - a. Elevation: xx.xx’
 - 3. LSL-1022: 118th St Pump Station Wet Well No.2 Low Level (Tertiary)
 - a. Elevation: xx.xx’
 - 4. LSH-1022: 118th St Pump Station Wet Well No.2 High Level (Tertiary)
 - a. Elevation: xx.xx’
 - 5. LSL-2020: Wilson Blvd Pump Station Wet Well Low Level (Tertiary)
 - a. Elevation: xx.xx’

6. LSH-2020: Wilson Blvd Pump Station Wet Well High Level (Tertiary)

a. Elevation: xx.xx'

B. Well Level Transducers

1. LE/LIT-1021: 118th St Pump Station Wet Well No.1 Level (Secondary)

a. Range: 0-x feet

2. LE/LIT-1022: 118th St Pump Station Wet Well No.2 Level (Secondary)

a. Range: 0-x feet

3. LE/LIT-2020: Wilson Blvd Pump Station Wet Well Level (Secondary)

a. Range: 0-x feet

C. Transit Time Ultrasonic Flowmeters

1. FE/FIT-1050: 118th St Pump Station Flow

a. Range: 0-x gpm

2. FE/FIT-2050: Wilson Blvd Pump Station Flow

a. Range: 0-x gpm

END OF SECTION 407000

SECTION 407166 - TRANSIT TIME FLOW METERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes transit time flow meters.
- B. Related Requirements:
 - 1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
 - 2. Section 407000 – Instrumentation for Process Systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Refer to Section 407000 – Instrumentation for Process Systems.
- B. Shop Drawings:
 - 1. Refer to Section 407000 – Instrumentation for Process Systems.

1.4 INFORMATIONAL SUBMITTALS

- A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.5 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. None Required

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.8 FIELD CONDITIONS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.9 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 DESCRIPTION

- A. Furnish sensors, offset and span adjustments, transmitters, interconnecting cables, and unit conversions and algorithms as required for application.

2.2 TRANSIT TIME FLOW METER SENSORS

- A. Manufacturers:
 - 1. Manufacturers and their products are subject to compliance with requirements. Provide the following :
 - a. Flexim FLUXUS F721 transmitter with FSK-NNNTS-000/LC sensors.
 - b. Substitutions: Not Permitted.
- B. Description: Nonintrusive transmitting and receiving transit time transducers clamped to outside of process pipe. For use with clean liquids (bubbles and solids <2%).
- C. Performance and Design Criteria:
 - 1. Design: According to AWWA M33.
 - 2. Velocity Range: 0 to 40 ft/sec (0 to 12.2 m/s).
- D. Pipe Size Supported: 2-inch to 48-inch. See drawings for pipe sizes required.
- E. Material: Stainless steel.
- F. Mounting Track: 304 stainless steel with strapping.

- G. Signal Cable: Provided by flow meter manufacturer. Length to be coordinated with the Contractor.
- H. Hazardous Area Certification: Class I, Div 2. (For Class I, Div. 1 requirement, provide intrinsic safety barrier for sensor installations.)
- I. Identification: Tab designating line size, orifice size, and flow direction.

2.3 TRANSMITTERS

- A. Manufacturers: Same as flow meter.
- B. Transmitter Output:
 - 1. 4 to 20 mA dc.
 - 2. Linear with flow rate.
 - 3. Linearity: ± 0.5 percent.
 - 4. Repeatability: ± 0.2 percent under simulated flow.
 - 5. Long-Term Drift: Less than 0.1 percent.
- C. Temperature Range
 - 1. Operating: -4°F to 131°F (-20°C to 55°C).
 - 2. Storage: -40°F to 158°F (-40°C to 70°C)
- D. Housing Rating: NEMA 4X
- E. Power: 120vac, 60 Hz or as indicated on the drawings.
- F. HMI:
 - 1. Touch-screen programming, functioning through enclosure window without opening enclosure.
 - 2. Display:
 - a. Size: Four lines by 16 characters.
 - b. Type: Backlit digital display.
 - c. User-selectable engineering units.
 - d. Readout of diagnostic error messages.
- G. Mounting:
 - 1. Mounting locations, remote from the sensors, as indicated on the drawings. Provide stainless steel mounting hardware.
 - 2. Refer to Instrumentation Detail drawing for mounting configuration.
- H. Transmitter Communication Interface: 4-20mA or as indicated on the drawings.
- I. Accessories/features:
 - 1. Current signal output simulation.
 - 2. Empty pipe detection.

3. Self-diagnostics.
4. Automatic zero adjustment.
5. Stainless-steel sunshield if mounted outdoors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.

3.2 IDENTIFICATION

- A. Refer to Section 407000 and Drawings for tagging requirements.

3.3 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and Owner to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

END OF SECTION 407166

SECTION 407853 - RELAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes control relays for SCADA system use.
- B. Related Requirements:
 - 1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.
 - 2. Section 406733, Panel Wiring.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.
- B. Shop Drawings:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. For each product furnished under this Section, provide 10% (minimum one) of the installed quantity.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.7 FIELD CONDITIONS

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.8 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE RELAYS AND TIME DELAYS

- A. Manufacturers:
 - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Allen Bradley.
 - b. IDEC
 - c. Omron
 - d. Schneider Electric.
 - e. Substitutions: Or equal.
- B. Type:
 - 1. General purpose plug-in type.
- C. Functional:
 - 1. Contact arrangement/function shall be as required to meet the specified control function; Mechanical life expectancy shall be in excess of 10 million.
 - 2. Duty cycle shall be rated for continuous operation; Units shall be provided with integral indicating light to indicate if relay is energized.
 - 3. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
 - 4. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.
- D. Physical:
 - 1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide contacts rated 5 amps at 28 VDC, for electronic (milliamp/millivolt) switching

- applicator provide gold plated contacts rated for electronic service; relays shall be provided with dust and moisture resistant covers.
- 2. All relays shall be provided with number of poles required to meet the design intent.

E. Options/Accessories Required:

- 1. Provide blade terminal din rail mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
- 2. Provide mounting rails/holders as required.
- 3. Provide LED lamp indicator.

2.2 SIGNAL RELAY SWITCHES (CURRENT TRIPS)

A. Manufacturers:

- 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Acromag.
 - b. Action Instruments Slim Pak.
 - c. Substitutions: Or equal.

B. Type:

- 1. Solid state, ASIC technology, electronic type.

C. Functional:

- 1. Input: 4-20 mA.
- 2. Output: Isolated contact output, double pole double throw, rated 5 amps at 120 VAC.
- 3. Accuracy: 0.1 percent.
- 4. Protection: Provide RFI protection.
- 5. Deadband: Adjustable between 0.1 and 5.0 percent of span.
- 6. Set point Adjustment: Single Point alarms shall be adjustable to trip on rising or falling input signal, dual point alarms shall be adjustable to trip on rising and falling input signals.
- 7. Repeatability: Trip point repeatability shall be at least 0.1 percent of span.

D. Physical:

- 1. Mounting: DIN rail.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 406733.

3.2 IDENTIFICATION

- A. Refer to Section 406717 for tagging requirements.

END OF SECTION 407853

SECTION 407856 - ISOLATORS, INTRINSICALLY SAFE BARRIERS, AND SURGE SUPPRESSORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes isolators, intrinsically safe barriers, and surge suppressors.
- B. Related Requirements:
 - 1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.
 - 2. Section 406733, Panel Wiring.
 - 3. Section 407000, Instrumentation for Process Systems.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.
- B. Shop Drawings:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. For each of the devices furnished under this Section, provide 10% (minimum one) of the installed quantity.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.7 FIELD CONDITIONS

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.8 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 SIGNAL ISOLATORS/BOOSTERS/CONVERTERS

- A. Manufacturers:
 - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Acromag.
 - b. Action Instruments Slim Pak.
 - c. Substitutions: Or equal.
- B. Type:
 - 1. Solid state, ASIC technology; electronic type.
- C. Functional:
 - 1. Accuracy: 0.15 percent.
 - 2. Inputs: Current, voltage, frequency, temperature, or resistance as required.
 - 3. Outputs: Current or voltage as required.
 - 4. Isolation: There shall be complete isolation between input circuitry, output circuitry, and the power supply.
 - 5. Adjustments: Zero and span adjustment shall be provided.
 - 6. Protection: Provide RFI protection.
- D. Physical:
 - 1. Mounting: DIN Rail.

2.2 INTRINSIC SAFETY BARRIERS

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Gems – 54800 (4-20mA) and 65800 (dry contacts).
 - b. R. Stahl - Intrinspak
 - c. Siemens Water Technologies – IS1 (4-20mA) and IS6 (dry contacts).
 - d. Substitutions: Or equal.

B. Type:

1. Barriers shall be of the solid-state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe usage in hazardous areas.
2. Provide a barrier for instrumentation and equipment transmitting analog or digital signals that originate in a hazardous area as indicated in the design documents.

C. Options Required:

1. Barriers shall match power supply provided.
2. Barriers shall be located in non-hazardous areas, and mounted within a separate enclosure suitable to the local environment. Refer to Section 406717 for requirements.

2.3 SURGE PROTECTION FOR CONTROL SYSTEMS

A. Manufacturers:

1. Manufacturers and their products are subject to compliance with requirements. Provide the following:
 - a. CITEL units, for services as follows:
 - 1) 230VAC power feeds (single phase): DS42S-230
 - 2) 120VAC power feeds: DS41S-120
 - 3) 24VDC power feeds: DS220S-24DC
 - 4) 24VDC/4-20mA analog signals: DLAW-24D3
 - 5) Profibus DP signals (inside panel): DLAW-06D3
 - 6) Category 5/5E/6 (inside panel): MJ8 series
 - 7) 24VDC/4-20mA analog or Profibus DP, and 120VAC power (at field instrument): CAD2 series
 - 8) Coaxial cable: P8AX series
 - b. Substitutions: Not Permitted.

- B. General - Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the plant electrical system. The protection systems shall be such that the protective level shall not interfere with normal operation but shall be lower than the instrument surge withstand level.

Protection shall be maintenance free and self-restoring. Devices shall have a response time of less than 50 nanoseconds and be capable of handling a discharge surge current (at an 8x20 μ s impulse waveform) of at least 8 kA. Ground wires for all instrumentation device surge protectors shall be connected to a low resistance ground.

- C. Provide protection of all analog signal (4-20 mA) circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Protection devices located near the transmitter shall be mounted in a separate NEMA 4X enclosure.
- D. Provide protection of all 120 VAC power feeds into control panels, instruments, and control room equipment.
- E. Non-Fiber Based Data Highway or Communications Circuits: Provide protection on all communication and data highway circuits that leave a building or are routed external to a building. Provide circuit protection at both ends of the line.
- F. RF Coaxial Cable: Provide protection on communication cables between radios and antennas, mounted either inside the panel, or in the wall of the enclosure in accordance with NEMA and UL 497E standards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 406733.

END OF SECTION 407856

SECTION 407859 - POWER SUPPLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes power supplies for SCADA control panels..
- B. Related Requirements:
 - 1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.
 - 2. Section 406733, Panel Wiring
 - 3. Section 406763, Control Panel Mounted UPS

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.
- B. Shop Drawings:
 - 1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 CLOSEOUT SUBMITTALS

- A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. For each device furnished under this Section, provide ten percent, minimum one, spare units.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.7 FIELD CONDITIONS

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.8 WARRANTY

- A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 24 VDC POWER SUPPLIES

- A. Manufacturers:
 - 1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
 - a. Allen-Bradley.
 - b. Phoenix Contact.
 - c. SOLA HD.
 - d. Substitutions: Or equal.
- B. Provide redundant 24 VDC power supplies that operate in parallel with an independent redundancy module to power field instruments and panel devices.
- C. Each 24 VDC power supply unit shall meet the following requirements:
 - 1. Input power: 115 VAC, plus or minus 10 percent, 60 Hz.
 - 2. Output voltage: 24 VDC.
 - 3. Output voltage adjustment: 5 percent.
 - 4. Line regulation: 0.05 percent for 10 volt line change.
 - 5. Load regulation: 0.15 percent no load to full load.
 - 6. Ripple: 3 mV RMS.
 - 7. Operating temperature: 32 to 140 degrees Fahrenheit.
- D. Size the 24 VDC power supply to accommodate the design load plus a minimum 25 percent spare capacity.
- E. If power supply on/off status signal is shown on drawings, provide a relay contact (internal to the power supply or redundancy module, or external if the power supply is not so equipped) to indicate on/off status of the power supply.

- F. Equip each power supply with a power on/off circuit breaker.
- G. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.
- H. Mount the 24 VDC power supply such that dissipated heat does not adversely affect other panel components.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Section 406733.

3.2 IDENTIFICATION

- A. Refer to specification Section 406717 for tagging requirements.

END OF SECTION 407859

SECTION 412213.13 - BRIDGE CRANES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Bridge crane systems.
- B. Related Requirements:
 - 1. Section 055000 – Metal Fabrications
 - 2. Section 099010 – Shop Priming
 - 3. Section 099100 - Painting
 - 4. Section 262923 - Variable-Frequency Motor Controllers: Hoist and Trolley drives.
 - 5. Section 400593 - Common Motor Requirements for Process Equipment: Electric motors and accessories normally supplied as part of equipment assemblies.

1.3 DEFINITIONS

- A. Runway: Structural supporting system attached to or part of building/structure to support bridge wheels.
- B. Bridge: Part of traveling crane consisting of supporting girders, end trucks/trolleys, wheels, and drive mechanism, carrying trolley-mounted hoist; of single- or double-girder construction. Bridge mobility by electric motor drive or hand chain drive.
 - 1. Top-Running Crane: Traveling crane bridge running on top of support girders.
 - 2. Under-Running Crane: Traveling crane bridge suspended below the crane runway; also known as underhung crane.
- C. Hoist: Electric motor or manually powered hoist with load hook to raise and lower a freely suspended load. Hook supported by one or more wire rope strands that reel from a drum mounted on hoist, or by one or more strands of metal chain. Standard headroom or close headroom construction.
- D. Pendant: Hand-operated controller for bridge, trolley, and hoist that hangs from the crane by a cable or portable.
- E. Trolley-Mounted Hoist: Assembly consisting of a wheeled trolley with electric or manual drive that moves along bridge girder(s), supporting hoist.
 - 1. Top-Running Hoist: Hoist trolley running on top of bridge girders

2. Underhung Hoist: Hoist trolley suspended from bridge girder(s)

1.4 PREINSTALLATION MEETINGS

- A. Section 013100 - Administrative Requirements: Requirements for preinstallation conference.
- B. Convene minimum [**one week**] [<_____> **weeks**] prior to commencing Work of this Section.

1.5 ACTION SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 1. Manufacturer catalog information for rail, trolley, hoist, motors, controls, description of operation, crane capacity, equipment layout, and dimensions including hoist coverage limits.
 2. Equipment data sheets for hoist selection indicating capacity, lift distance, lift speed, motor data, weight, dimensions, and materials of construction.
 3. Equipment data sheets for hoist trolley selection indicating capacity, speed, motor data, dimensions, weight, and materials of construction.
 4. Equipment data sheets for bridge trolley selection indicating capacity, speed, motor data, dimensions, weight, and materials of construction.
 5. List of manufacturer's recommended spare parts.
- C. Shop Drawings:
 1. Dimensional drawings and details crane and runway, including clearances, principal dimensions, details of structural connections, and component details.
 2. Erection drawings.
 3. Support details and loads at each support.
 4. Control panel layout, location, control schematics, and wiring diagrams.
 5. Bill of materials of crane components.

1.6 DELEGATED DESIGN SUBMITTALS:

1. Submit signed and sealed design calculations and assumptions for:
 - a. Sizing of bridge girders and supports.
 - b. Selection and sizing of hoist brakes.
 - c. Sizing of bridge and trolley brakes.
 - d. Tabulation of crane rail stop load reaction on the structure.
 - e. **[Seismic analysis of bridge girders and end trucks.]**

1.7 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Certificate:

1. Certify that products meet or exceed standards referenced herein.
 2. Certify that final installation meets or exceeds standards referenced herein and standards of each manufacturer providing components for the system.
- B. Test and Evaluation Reports:
1. Mill Test Reports: Indicate for bridge.
 2. Inspection and Rated-Load Test Reports: Indicate according to ASME B30.2.
 3. Crane certification documentation.
- C. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- D. Source Quality-Control Submittals: Indicate results of [shop] [factory] tests and inspections.
- E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- F. Qualifications Statements.
1. Submit qualifications for manufacturer, installer, and licensed professional.
 2. Submit manufacturer's approval of installer.
 3. Welder certificates: Submit certifications of welders and welding procedures employed on Work verifying AWS qualification within previous 12 months.

1.8 CLOSEOUT SUBMITTALS

- A. Section 017700 - Execution and Closeout Requirements
- B. Project Record Documents:
1. Record schematic, wiring, and layout information for crane and radio controls.

1.9 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 017823 – Operation and Maintenance Data
- B. Spare Parts:
1. Furnish following spare parts for each bridge crane:
 - a. [One] <_____> complete set of linings for each type and size of brake.
 - b. [One] <_____> set of collector shoes.
 - c. [One] <_____> wire rope with end fittings.
 - d. [One] <_____> NiCad battery with battery charger.

1.10 QUALITY ASSURANCE

- A. Design and Fabrication: Comply with the following:

1. AISC 325, Steel Construction Manual
 2. ANSI MH27.1 Specifications for Patented Track Underhung Cranes and Monorail Systems
 3. ASME B30.10 Hooks
 4. ASME B30.11 Monorails and Underhung Cranes
 5. ASME B30.16 Overhead Underhung and Stationary Hoists
 6. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 7. NEMA ISC 2 Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts
 8. NEMA ISC 8 Application Guide for Industrial Control and Systems Crane and Hoist Controllers
 9. OSHA 1910.179 Overhead and Gantry Cranes
 10. OSHA 29 CFR 1926, Subpart N
 11. [ASME HST-1, Performance Standard for Electric Chain Hoists]
 12. [ASME HST-2, Performance Standard for Hand Chain Manually Operated Chain Hoists]
 13. [ASME HST-4, Performance Standard for Overhead Electric Wire Rope Hoists]
 14. [ASME HST-5, Performance Standard for Air Chain Hoists]
 15. [ASME HST-6, Performance Standard for Air Wire Rope Hoists]
 16. [ASME B30.17 Cranes and Monorails (with Underhung Trolley or Bridge)]
 17. [CMAA 74]
 18. [ASME B30.2]
 19. [CMAA 70]
- B. Installation and Start-Up: Comply with:
1. OSHA 1919.71 Unit Proof Test and Examination of Cranes
 2. ASME B30.16
- C. All components to be UL listed where UL listed components are available.
- D. Perform Work according to <_____> standards.
- E. Maintain <_____> [copy] [copies] of each standard affecting Work of this Section on Site.

1.11 QUALIFICATIONS

- A. Manufacturer:
1. Company specializing in manufacturing products specified in this Section with minimum **[three]** <_____> years' **[documented]** experience.
 2. Member of the Hoist Manufacturers Institute
 3. [Member of the Monorail Manufacturers Association.]
- B. Installer: Company specializing in performing Work of this Section with minimum **[three]** <_____> years' **[documented]** experience **[and approved by manufacturer]**.
- C. Licensed Professional: **[Professional engineer]** <_____> experienced in design of specified Work and licensed **[at Project location]** **[in State of <_____>]**.
- D. Welders: AWS qualified within previous 12 months for employed weld types.

1.12 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- C. Store materials according to manufacturer instructions.
- D. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Provide additional protection according to manufacturer instructions.

1.13 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.

1.14 WARRANTY

- A. Section 017700 - Execution: Requirements for warranties.
- B. Furnish [**five**] <_____>-year manufacturer's warranty for bridge cranes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Crane systems: Whiting Corp., American Monorail, Inc., ACCO Loudon Systems, or equal.
- B. Hoist equipment: Yale Hoists, Coffing Hoists, Harnischfeger, Wright, Shaw Box, or equal.
- C. Bridge Crane Systems Assemblers: Capco Crane and Hoist, Platnick Steel and Engineering, The Cooke Corp, or equal.
- D. Substitutions: [As specified in Section 016000 - Product Requirements] [Not permitted].
***** [OR] *****
- E. Furnish materials according to <_____> standards.

2.2 Performance and Design Criteria Crane [BC-1] <____>:

- A. Location: <____>

- B. Service Class: [C]<_____>.
- C. Environment:
1. **[Indoor]** **[Outdoor]**,
 2. [Unclassified] [Class I, Division <1> <2>, Group D].
- D. System Capacity: <_____> **tons** (<_____> **kg**).
- E. System Electric Power Supply: **[480 Volt, 60 Hz, 3 Phase]**
- F. Runway: [Provided under this Section] [Provided under <Structural>. Ref Section _____]
1. [Steel beam I-beam or specially fabricated steel sections supported by building structure]
 2. [Top mounted ASCE crane rail.]
 3. [[Standard steel structural beam] [specially fabricated steel sections] with hanger supports from building structure]
 4. Nominal span between supports: <_____> **inch** (<_____> **mm**)
 5. Runway reach (floor to underside of runway beam): [<_____>] [As shown on Drawings]
- G. Bridge:
1. Type: **[Top]** **[Under]**-running
 2. Construction: **[Single]** **[Double]**-girder.
 3. Bridge Capacity: <_____> **tons** (<_____> **kg**).
 4. Bridge Drive: [Manual] [Geared][Electric]
 5. Drive Type: [Single with cross shaft] [Dual on each end truck]
 6. Bridge Speed: **[Single]** <_____> **fpm** (<_____> **m/min**) **[Two]** <_____> **fpm** (<_____> **m/min**) **[Multi-speed]** <_____> **fpm** (<_____> **m/min**) Max].
 7. Bridge Drive Power: <_____> **hp** (<_____> **kW**)
 8. Bridge Motor: [TEFC] [TENV] [explosion proof], [single speed] [two-speed] [variable speed]
 9. Electrification: [Conductor Bar] [Festoon] [Cable Reel]
- H. Main Hoist:
1. Configuration: [Underhung] [Top Running]
 2. Headroom: [Close] [Standard]
 3. Hoist Type: [Manual chain] [Electric chain] [Electric wire rope]
 4. Hoist Service Class: [H1] [H2] [H3] [H4] [H5]
 5. Reeving: [Single] [Double]
 6. Hoist Wire Rope Material: **[Type 316 stainless steel ASTM A580/A580M]** [carbon steel **A1023/A1023M**].
 7. Hoist Suspension: [Lug mount] [Hook mount] [Trolley]
 8. Hoist Capacity: <_____> **tons** (<_____> **kg**) [As indicated **on Drawings**]
 9. Hoist Lift Distance: [<_____> **feet** (<_____> **m**)] [As indicated on Drawings]
 10. Maximum allowable headroom: [<_____> **feet** (<_____> **m**)] [As indicated on Drawings]

11. Hoist Lifting Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max].
 12. Hoist Motor: [TEFC] [TENV] [explosion proof], [single speed] [two-speed] [variable speed]
 13. Hoist Motor Power: < _____ > hp (< _____ > kW)
 14. Trolley Type: [Integral to hoist] [Hook mount] [Lug mount] [Separate tractor trolley]
 15. Trolley Drive: [Plain (manual)] [Geared (manual)] [Electric]
 16. Trolley Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max]
 17. Trolley Motor: [TEFC] [TENV] [explosionproof], [single speed] [two-speed] [variable speed]
 18. Trolley Drive Power: < _____ > hp (< _____ > kW)
 19. Electrification: [Conductor Bar] [Festoon] [cable reel] [tag line]
 20. Hoist/Trolley Control Enclosure: NEMA 250 Type [1] [4] [4X] [7] < _____ >.
- I. Auxiliary Hoist:
1. Configuration: [Underhung] [Top Running]
 2. Headroom: [Close] [Standard]
 3. Hoist Type: [Manual chain] [Electric chain] [Electric wire rope]
 4. Reeving: [Single] [Double]
 5. Hoist Wire Rope Material: [Type 316 stainless steel ASTM A580/A580M] [carbon steel A1023/A1023M].
 6. Auxiliary Hoist Capacity: < _____ > tons (< _____ > kg)] [As indicated on Drawings]
 7. Hoist Suspension: [Lug mount] [Hook mount] [Trolley]
 8. Auxiliary Hoist Lift Distance: [< _____ > feet (< _____ > m)] [As indicated on Drawings]
 9. Maximum allowable headroom: [< _____ > feet (< _____ > m)] [As indicated on Drawings]
 10. Auxiliary Hoist Lifting Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max].
 11. Auxiliary Hoist Motor: [TEFC] [TENV] [Explosionproof], [single speed] [two-speed] [variable speed]
 12. Auxiliary Hoist Motor Power: < _____ > hp (< _____ > kW)
 13. Trolley Type: [Integral to hoist] [Hook mount] [Lug mount] [Separate tractor trolley]
 14. Trolley Drive: [Plain (Manual)] [Geared (Manual)] [Electric]
 15. Trolley Speed: [Single < _____ > fpm (< _____ > m/min)] [Two < _____ / _____ > fpm (< _____ / _____ > m/min)] [Multi]-speed < _____ > fpm (< _____ > m/min) Max]
 16. Auxiliary Trolley Motor: [TEFC] [TENV] [Explosionproof], [single speed] [two-speed] [variable speed]
 17. Auxiliary Trolley Drive Power: < _____ > hp (< _____ > kW)
 18. Electrification: [Conductor Bar] [Festoon] [Cable reel] [Tag line]
 19. Hoist/Trolley Control Enclosure: NEMA 250 Type [1] [4] [4X] [7] < _____ >.
- J. Control Panel:
1. Construction:

- a. NEMA 250 Type [12] [4X] [7] <_____>.
 - b. Single-point power connection and grounding lug.
 - c. Location: Factory mounted on crane bridge.
2. Limit Switches:
 - a. Description:
 - 1) Automatically stop hoist motion when block reaches its highest position.
 - 2) Prevent trolley and bridge from striking bumpers.
 - b. Comply with NEMA ICS 2.
 - c. Enclosures: Comply with NEMA 250 Type [12] [4X] [7] <_____>.
 - d. **[Furnish minimum of one spare isolated set of normally open and normally closed contacts.]**

K. Controls:

1. Description: Push-button pendant station [and radio remote control, only one of which may have control at any given time as selected by a master switch].
2. Comply with NEMA ICS 8 and CMAA 70/74.
3. Push-Button Pendant:
 - a. Location: [Suspended from trolley mounted hoist] [Suspended from fixed location on bridge with festoon control connection to hoist/trolley] [Wall mounted with hard wire and festoon control connection to bridge and hoist].
 - b. Elevation: [Fixed suspension [4] <_____> feet ([1.2] <_____> m) above operating floor.] [Pendant Reel: Furnish pendant reel with cable to reach to [4] <_____> feet ([1.2] <_____> m) above all floor levels traversed by crane.]
 - c. Controls:
 - 1) Key operated POWER ON-OFF switch
 - 2) POWER ON light
 - 3) RAISE /LOWER hoist control
 - 4) LEFT/RIGHT trolley control
 - 5) FORWARD/REVERSE bridge control
 - 6) Limit switch BYPASS button
 - 7) Master Switch: To select between pendant and remote radio control.
 - 8) [Speed control for functions incorporating [two-speed] [variable speed] drive]
4. Remote Radio Control:
 - a. Type: Portable.
 - b. Batteries: Rechargeable NiCad.
 - c. Controls:
 - 1) Key operated POWER ON-OFF switch
 - 2) POWER ON light
 - 3) RAISE /LOWER hoist control

- 4) LEFT/RIGHT trolley control
- 5) FORWARD/REVERSE bridge control
- 6) BATTERY MONITOR light.
- 7) Blue light under crane to be energized and visible from every direction whenever crane is operated by radio control.

d. Operating Frequency:

- 1) Comply with [FCC Part 15] <_____>.
- 2) Bandwidth: <_____> MHz to <_____> MHz.

2.3 COMPONENTS

A. Electric Motors:

1. As specified in Section 400593 - Common Motor Requirements for Process Equipment.
2. Comply with CMAA 74 and MH27.1

B. Runway track

1. [Patented track continuously welded high-carbon steel with raised tread.] [Steel structural beam [<specify>]]
2. Ends: Factory prepared.
3. Comply with CMAA 74 and MH27.1
4. Bolted trolley stops at every open end.
5. Provide end stop limit switch tripping bars and fasteners.
6. Provide all additional steel supporting members required for support of monorail runway from structure

C. [Manual Chain Hoist:

1. Comply with ASME HST-2, Service Class 1.
2. Brake: Mechanical type.
3. Provide overload limiting device
4. Chains:
 - a. Type: **Welded link**.
 - b. Material: [Steel] [Galvanized Steel] [Stainless steel]
 - c. Accessories:
 - 1) Storage bucket for chain hoists with 10-foot (3-m) or greater lift.
 - 2) Chain guides.

5. Hook:

- a. Material: [Forged] [Stainless] steel.
- b. Swivel: Anti-friction type, allowing 360-degree rotation of load.
- c. Furnish spring-loaded safety latch.
- d. Furnish nuts keyed to hook shanks by setscrew.]

D. Electric Hoist

1. Comply with ASME HST-[1] [4]
2. Service Class: H3
3. Motor: Direct-coupled
4. Brakes: Solenoid type.
5. Control Panel:
 - a. Factory mounted.
 - b. Single-point power connection and grounding lug.
6. Controls:
 - a. Pendant Push-Button Station:
 - 1) Comply with NEMA ICS 8.
 - 2) Furnish mounting bracket on hoist to stow pendant when not in use.
 - 3) Push Buttons: RAISE/LOWER, [FORWARD/REVERSE]
 - 4) [Pendant cable reel suspension: Adjustable, self-holding in last position.]
 - b. Controls to permit inching in both directions under full load, automatically regulated acceleration, and rapid brake response.
7. Hoist[/Trolley] Limit Controls:
 - a. Adjustable upper and lower overtravel limit stops
 - b. Adjustable overload limit control
 - c. [Trolley stop limit switch control at each terminus of runway]
8. Sheaves:
 - a. Material: Forged steel.
 - b. Bearings: Permanently lubricated roller type; ABMA 11.
 - c. Minimum Diameter: 20 times rope diameter.
9. Hook:
 - a. Material: [Forged] [Stainless] steel.
 - b. Swivel: Anti-friction type, allowing 360-degree rotation of load.
 - c. Furnish spring-loaded safety latch.
 - d. Furnish nuts keyed to hook shanks by setscrew.

E. Air Hoist

1. Comply with ASME HST-[5] [6]
2. Service Class: A4
3. Air Motor: Direct-coupled
4. Brakes: Mechanical.
5. Controls:
 - a. Pendant Push-Button Station:

- 1) Trolley supported with air hose connection
 - 2) Push Buttons: RAISE/LOWER, [FORWARD/REVERSE]
- b. Controls to permit inching in both directions under full load, automatically regulated acceleration, and rapid brake response.
6. Hoist[/Trolley] Limit Controls:
 - a. Adjustable upper and lower overtravel limit stops
 - b. Adjustable overload limit control
 - c. [Trolley stop limit switch control at each terminus of runway]
7. Sheaves:
 - a. Material: Forged steel.
 - b. Bearings: Permanently lubricated roller type; ABMA 11.
 - c. Minimum Diameter: 20 times rope diameter.
8. Hook:
 - a. Material: [Forged] [Stainless] steel.
 - b. Swivel: Anti-friction type, allowing 360-degree rotation of load.
 - c. Furnish spring-loaded safety latch.
 - d. Furnish nuts keyed to hook shanks by setscrew.
- F. [[Plain] [Geared] Trolley:]
 1. Comply with applicable ASME HST.
 2. Wheels:
 - a. Removable without removing trolley from track.
 - b. Treads: Hardened.
 - c. Electroplated with zinc.
 3. Furnish rubber bumper devices to maintain separation if two or more hoists are located on same monorail track.
 4. [Geared Trolley:
 - a. Gear trains, with operating parts totally enclosed.
 - b. Lubrication: [**Oil bath**] [**Grease**].
 - c. [Trolley Brake: Mechanical type.]
 - d. [Hand Drive Chain: **Welded link [steel]** [**stainless steel**]
- G. [Electric Trolley:
 1. Wheels: Comply with CMAA 74 and MH27.1
 2. Brakes:
 - a. Magnetic-release disc type.
 - b. Integrally mounted to motor.

3. Furnish rubber bumper devices to maintain separation if two or more hoists are located on same monorail track.]

H. [Electrification:

1. Provide junction box to connect power feeder from disconnect switch (by Div. 26).
2. Conductor Bar System
 - a. Single conductor bars enclosed in molded high dielectric plastic cover
 - b. Copper conductors
 - c. Attach to monorail runway
 - d. Trolley mounted adjustable spring-loaded sliding shoe collectors
 - e. Conductor sizing/rating: Comply with CMAA 74 and MH27.1
 - f. No exposed current-carrying surfaces
 - g. Manufacturers: Insul-8-Bar, Safe-T-Bar, Duct-O-Bar or equal.
3. Festoon System:
 - a. Description:
 - 1) Multi-Conductor power supply cables suspended from trolleys mounted on heavy-duty C-track parallel to hoist monorail.
 - 2) Construction: Non-sparking.
 - b. Cables:
 - 1) UL-listed neoprene-jacketed, stranded multi-conductor flat cables.
 - 2) Conductor sizing/rating: Comply with CMAA 74 and MH27.1
 - 3) Length: 110 percent of required length.
 - c. Trolleys:
 - 1) Furnish towing and manufacturer's standard trolleys.
 - 2) Furnish stainless steel tow cable assembly for trolley spacing.
 - 3) Furnish strain-relief cable between first trolley and adjacent wall.
 - d. Festoon Runway:
 - 1) Material: Aluminum or Type 316 stainless steel.
 - 2) End Clamps: Furnish fixed end clamps with outrigger arms.
4. Cable Reel:
 - a. Swivel mounted
 - b. Self-tensioning to limit cable droop
 - c. Construction: Weather-resistant, self-winding, [**explosion-proof**,] and spring operated.
 - d. Roller outlets.
 - e. Conductor sizing/rating: Multi-conductor, UL listed, neoprene jacketed, stranded cable, comply with CMAA 74 and MH27.1]

- f. Manufacturers: Gleason Reel Div. Maysteel Products, Aero-Motive Mfg., Dresser Industries, or equal.]
- I. Mounting Hardware: [Steel] [Galvanized Steel] [[**Type 316**] stainless steel].
- J. [Service Platform
 - 1. Full length of crane girder
 - 2. Fabricated of steel supports with checkered steel plate or grating deck, 42-inch high guard rails, and kick plate.
 - 3. Design to CMAA 70 and OSHA
 - 4. Platform elevation to avoid interference with lifting device and provide overhead clearance not less than 78 inches.
 - 5. Provide fixed platform with access ladder and ladder safety guards for access to service platform.
 - 6. Provide self-closing/latching gates on both platforms.]
- K. Labeling
 - 1. Safety Signs: Comply with NEMA 535.
 - 2. Clearly label capacity of bridge and hoist(s) on each piece of equipment.
- L. Factory Coatings:
 - 1. Apply factory finish paint or coatings to all exposed component surfaces.
 - 2. Apply rust inhibitive coatings to all ferrous surfaces not designated to be painted.
 - 3. Factory surface preparation, priming, and painting to be manufacturer's standard and as specified in Division 9.
 - 4. Finish coat colors to conform to industry standard. Submit color selections as offered.

2.4 SOURCE QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.
- B. Factory-assemble individual crane components and perform shop inspection and testing of completed assemblies.
- C. Testing:
 - 1. Perform "no-load" running test of controls and drive machinery to ensure proper operation.
 - 2. Proof-test load chains. Comply with applicable ASME HST Standard
 - 3. Comply with OSHA 1919.71
 - 4. Electrical:
 - a. Test hoist, trolley, and bridge controls.
 - b. Verify independent operation of pendant and radio controls.
 - c. Verify operation of limit switches and bypass controls.
- D. [Owner Inspection:

1. Make completed hoist assembly available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least [seven] <_____> days before inspection is allowed.

E. Owner Witnessing:

1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Notify Owner at least [seven] <_____> days before inspections and tests are scheduled.]

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017700 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that systems are ready to receive Work.
- C. Verify that field dimensions are as indicated on [Shop] Drawings.

3.2 INSTALLATION

- A. According to manufacturer instructions and as indicated on Drawings.
- B. Construction: Comply with referenced standards and OSHA 1920.179.
***** [OR] *****
- C. Installation Standards: Install Work according to <_____> standards.

3.3 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
***** [OR] *****
- B. Section 017000 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- C. Inspection: Check hoist and motor for excessive vibration and noise.
- D. Testing:
 1. Notify Engineer and perform all testing in the presence of Engineer.
 2. Perform initial "no-load" running test of controls and drive machinery to ensure proper operation.
 - a. Operate crane through complete lift and lowering cycle and through complete travel of bridge and trolley under full-load and no-load conditions.

- b. Verify that equipment performs smoothly and safely.
 - c. Verify independent operation of pendant and radio controls.
 - d. Verify that pendant cable length is sufficient to permit operation from desired floor levels.
 - e. Verify that hoist and bridge motions operate as required.
 - f. Verify that limit switches operate as required.
- 3. Perform load tests on bridge, hoist, and trolley through-out full range of access of the bridge crane.
 - a. Load Test Certification: Comply with OSHA Part 1910.179.
 - b. Unit Proof Test: Comply with OSHA Part 1919.71, and ASME B30.16.
 - c. Verify that temperature within enclosures is within tolerance after full-load tests.
- E. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than <_____> [days] [hours] on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.
- F. Equipment Acceptance:
 - 1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 - 2. Make final adjustments to equipment under direction of manufacturer's representative.
- G. Repair damaged coatings with material equal to the original coating and as specified in Section 099100 - Painting .

3.4 ADJUSTING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Field-calibrate local controls and indicators.

3.5 DEMONSTRATION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate crane operation, routine maintenance, and emergency repair procedures to Owner's personnel.

3.6 PROTECTION

- A. Section 017000 - Execution and Closeout Requirements: Requirements for protecting finished Work.

- B. Construct temporary protection for equipment and installations, consisting of canvas, heavy plastic, plywood, or other suitable materials, closed tightly and dustproof.

END OF SECTION 412213.13

SECTION 432513
DRY-PIT SUBMERSIBLE SOLIDS HANDLING PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, equipment and incidentals required and install, place in operation and field test seven (four at 118th St and three at Wison Blvd) horizontally mounted dry-pit submersible wastewater pumps as shown on the Drawings and specified herein. The equipment to be furnished and installed shall be as shown on the Drawings and shall include pumps, motors, VFDs, control panels and control systems, and appurtenances, all tested and ready for operation.
- B. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, factory testing, delivery and complete installation and field testing of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in these Specifications or not.
- C. Pump motors, cables and appurtenances shall be rated for operation in a Unclassified environment.
- D. The Contractor shall require the pump manufacturer to coordinate pump and motor design with the manufacturer of the variable frequency drives and furnish the drives, as specified in Section 16482.

1.02 RELATED WORK

- A. Submittals are included in Section 013300.
- B. Operation and maintenance is included in Section 017823.
- C. Warranties are included in Section 017700.
- D. Concrete work and the installation of anchor bolts are included in Division 3; however, anchor bolts for these units as recommended by the pump manufacturer shall be furnished by the Manufacturer under this Section.
- E. Instrumentation and control description is included in Division 27.
- F. Valves, mechanical piping and appurtenances and pipe hangers and supports are included in Division 33.
- G. Electrical work is included in Division 26.

1.03 REFERENCE STANDARDS

- A. Design, manufacturing and assembly of elements of the equipment herein specified shall be in accordance with, but not limited to, published standards of the following, as applicable:

1. American Gear Manufacturers Association (AGMA)
2. American Institute of Steel Construction (AISC)
3. American Iron and Steel Institute (AISI)
4. American Petroleum Institute (API)
5. American Society of Mechanical Engineers (ASME)
6. American National Standards Institute (ANSI)
7. American Society for Testing Materials (ASTM)
8. American Welding Society (AWS)
9. American Bearing Manufacturers Association (ABMA)
10. Hydraulic Institute Standards (current editions)
11. Institute of Electrical and Electronics Engineers (IEEE)
12. National Electric Code (NEC)
13. National Electrical Manufacturers Association (NEMA)
14. Occupational Safety and Health Administration (OSHA)
15. Steel Structures Painting Council (SSPC)
16. Underwriters Laboratories, Inc. (UL)
17. Factory Mutual (FM)

- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 SYSTEM DESCRIPTION

- A. There will be two independent Master Wastewater Pump Stations covered under this specification. Each system will pump raw wastewater from a wetwell to the JEA wastewater system in a forcemain. The equipment to be furnished under this Section shall include seven (four pumps at 118th Street MPS and three pumps at Wilson Boulevard MPS) horizontally mounted submersible wastewater pumps in a dry-pit configuration, with motors, VFDs, and accessories, all as specified herein and as shown on the Drawings. Contractor shall coordinate and be fully responsible for proper operation and compatibility between items in this scope of work and items in Division 13.

1.05 QUALIFICATIONS

- A. To assure unity of responsibility, the pumps, motors, VFDs, and other auxiliary equipment, and materials specified in this Section shall be furnished and coordinated by the pump

manufacturer (Manufacturer) who shall assume responsibility for the satisfactory operation of the entire pumping system including pumps, motors, VFDs, and accessories.

- B. The pumps and other equipment covered by this Specification shall be standard production units of the manufacturers, currently available and listed in the respective manufacturer's catalogs. The pumps furnished shall be in accordance with the Hydraulic Institute Standards and shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.
- C. The Manufacturer shall have an authorized warranty center within a 300-mile radius of the job site, fully staffed with factory trained mechanics, and equipped with a stock of all necessary spare parts for each model of pump furnished under this Contract. The service facility shall be an established entity prior to delivery of equipment for this project.
- D. The VFDs furnished shall meet all requirements of JEA standards and as specified in Division 16 and below.
- E. All equipment furnished under this Specification shall be new and unused, and shall be the standard product of Xylem Corporation (Flygt).
- F. The pumping equipment shall be furnished complete with accessories required and shall meet the detailed requirements of the Specifications.
- G. Prior to manufacture, a submittal must be forwarded to the Engineer indicating that the required vibration analyses outlined herein have been performed and that the specified limitations will be met. For the dynamic vibration analysis described, minimum and maximum operating speeds will be in accordance with the operating speeds required to satisfy the conditions of operation specified in Article 2.02. The dynamic vibration analysis required by the following paragraphs shall be performed by Mechanical Solutions Inc. (MSI) of Whippany, NJ, or Engineering Dynamics Inc. (EDI) of San Antonio, TX or alternatively by the Manufacturer if Manufacturer's demonstrated, successful, vibration analysis experience, in at least twenty projects similar in scope, with proposed personnel involved, may be acceptable to the Engineer with analyses in accordance with the specified requirements.
 - 1. Structural dynamic analysis of the combined pump/motor and the nearby foundation and the piping out to the first pipe restraint or expansion joint. Analysis shall not simply assume the foundation is rigid rather it shall incorporate foundation design shown on the Drawings. The structural dynamic analysis shall predict that no first or second bending mode frequencies will exist within a pump speed and vane pass frequency range from 20 percent below minimum operating speed of 45 Hz to 20 percent above maximum operating speed.
 - 2. Lateral rotodynamic analysis - The lateral rotodynamic analysis shall identify and predict that the first lateral critical speed shall be at least 20 percent above the maximum pump speed and vane pass frequency or 20 percent below the minimum pump speed. Any pump component excited resonant frequency shall be no closer than plus or minus 20 percent of the natural frequency of any part of the installed assembled pumping unit. Any lateral rotodynamic frequencies not satisfying the +/- 20% margins shall not result in a forced damped response that will allow contact between the shaft and journal bearings.

3. A torsional rotordynamic analysis of the complete rotating system shall identify and predict that no torsional natural frequencies occur within a separation margin extending from 20 percent below to 20 percent above the specified pump operating speed range. Additionally, no natural frequencies shall be +/- 10% of 2x times running speed, line frequency, 2x line frequency, vane pass frequency, and VFD control frequencies (if applicable). If a design modification (i.e., such as a shaft diameter change or number of impeller vanes) cannot resolve a separation margin deficiency or is not practical, a forced damped response analysis shall be performed to show that infinite life will be achieved with a safety factor of at least two.
4. Campbell diagrams shall be submitted, documenting the structural lateral, rotating component lateral, and torsional analysis results, graphically demonstrating the separation margins specified above.
5. The pumps shall operate throughout the entire operating range with the maximum vibration velocity in inches per second RMS, measured in the field, conforming to the requirements of ANSI/HI 11.6.

1.06 SUBMITTALS

- A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of the General Conditions and Section 01300. Submittals shall include at least the following:
 1. Shop and erection drawings showing all important details of construction, dimensions and anchor bolt installation requirements.
 2. Descriptive literature, bulletins, and/or catalogs of the equipment. Sufficient data shall be submitted to document previous production of each pump model proposed for use on this Contract.
 3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves to ANSI/HI 11.6 acceptance grade 1U, based on actual factory tests of similar units, which show that they meet the specified requirements for head, flow rate, efficiency, NPSH3, submergence and horsepower. Curves shall be submitted on 8-1/2-inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from zero flow at shut off head to pump flow rate at minimum specified total head (TH). The POR and AOR (refer to ANSI/HI 9.6.3) shall be clearly shown on the curves. Catalog sheets showing a family of curves will not be acceptable.
 4. The total weight of the equipment including the weight of the single largest item.
 5. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, control panels and related systems.
 6. A complete total bill of materials of all equipment.
 7. A list of the manufacturer's recommended spare parts to be supplied, with the manufacturer's current price for each item. Include gaskets, seals, etc. on the list. List bearings by the bearing manufacturer's numbers only.

8. All submittal data required by the General Conditions.
 9. Complete motor data, including, but not limited to:
 - a. Type of enclosure design
 - b. Rated horsepower
 - c. Rated voltage
 - d. FLA
 - e. Starting current
 - f. LRA
 - g. LR KVA
 - h. NEMA starting code letter and insulation code letter
 - i. RPM
 - j. Input power in kW at nameplate rating
 - k. Starting calculations
 - l. Cable size
 - m. Efficiency at 50%, 75% & 100% load, and power factor at 50%, 75% & 100% load
 - n. Winding temperature rise
 - o. Vibration design limits
 - p. Speed torque curves
 - q. Recommended trip and alarm settings for temperature and vibration protective devices
 - r. Power and control cable size and materials of construction , details of cable sealing method, description and type of motor thermal protection, description of insulation system and service factor.
 - s. Submit a certified statement from the motor manufacturer that the motors are capable of a minimum of 12 variable frequency drive starts per hour and continuous operation on the power supply from the variable frequency drives to be furnished without affecting their design life for bearings or windings. This requirement does not replace nor relieve submittal requirements under Division 16.
 10. Certified agreement to the conditions of the warranty.
 11. Submit description of factory test plan including test procedures and equipment.
 12. Submit for approval results of factory testing and field testing.
 13. Critical speed analyses report including the specified Campbell diagrams and a statement of guarantee that the critical speed analyses as required in Paragraph 1.05G. of this Section have been completed and that the specified limitations will be met.
- B. In the event that the equipment offered does not conform with all of the detailed requirements of the Specifications, describe completely all nonconforming aspects. Failure to describe any and all deviations from the specifications will be cause for rejection.
- 1.07 MANUFACTURER SERVICES INCLUDING OPERATING INSTRUCTIONS
- A. Operating and Maintenance Manual:
1. Operating and maintenance manual shall be furnished by the Manufacturer to the Engineer as provided for in Section 01730. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists,

description, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include trouble shooting data, full preventative maintenance schedules, and complete spare parts lists with ordering information.

B. Installation Inspection and Startup:

1. The Contractor shall include in his bid price the services of a Manufacturer's factory representative who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and start-up. If there are difficulties in operation of the equipment because of the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner. The listed service requirements are exclusive of travel time, and shall not limit or relieve the Contractor of the obligation to provide sufficient service necessary to place the equipment in satisfactory and functioning condition. Also refer to requirements in PART 3 of this Section.
2. Installation inspection: Complete review of the installation and provide written certification that the installation is complete and operable in all respects, and that no conditions exist which may affect the warranty. The Manufacturer shall supply the installation inspection services of an experienced Manufacturer's factory representative to verify the proper pump installation. Qualified supervisory services, including Manufacturers' Factory representatives, shall be provided to ensure that the installation is done in a manner fully approved by the Manufacturer. The Manufacturer's factory representative shall specifically approve the installation and alignment of the pump with the motor, the grouting, and the alignment of the connecting piping and the installation of the field installed packing or mechanical seal. If there are difficulties in the start-up or operation of the equipment due to the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner. Services of the Manufacturer's factory representative and training shall be provided when the first pump is started, with follow-up visits upon start-up of each subsequent pump.
 - a. Minimum time on-site shall be one 8-hour day per pump.
3. Start-Up: Provide written report, summarizing test procedures, tested and measured variables (flow rates, total heads, shaft-speed, vibration measurements, etc.):
 - a. Minimum time on-site shall be one 8-hour day per pump.

C. Training:

1. Field and classroom instruction on operation and maintenance of the equipment, including start-up, shut-down troubleshooting, lubrication, maintenance and safety.
2. The Manufacturer shall provide detailed manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.
3. The Manufacturer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, such materials shall be delivered to Owner.
 - a. Minimum time on-site shall be one 8-hour day.

- D. The Contractor alone shall be responsible for requesting these services, and shall coordinate these requests with all other relevant trades, to ensure the effectiveness of the Manufacturers' service. In the event that the lack of coordination by the Contractor results in the need to recall the Manufacturer's factory representative, the lost time shall not be counted against the above days.

1.08 TOOLS AND SPARE PARTS

- A. The Manufacturer shall furnish a complete list of recommended spare parts, gaskets, lubricants, sealants and heat transfer medium necessary for the first five years operation of each pumping system.

1.09 PRODUCT HANDLING

- A. All equipment and parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of fabrication, including storage in accordance with Manufacturer's requirements until final delivery to the job site.
- B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.
- C. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto or by other approved means.
- D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.
- E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.
- F. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.10 WARRANTY

- A. All equipment supplied under this section shall be warranted for a period of two years by the Contractor and the Manufacturer. Warranty period shall commence on the date of Owner acceptance, as outlined in Division 1 and in Division 0.
- B. In addition, Manufacturer shall warrant the pump/motor for a period of five years, prorated after the initial 1.5 years. This Manufacturer warranty duration includes the warranty period identified above and as outlined in Divisions 1 and 0.
- C. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s) and the unit(s) restored to service at no expense to the Owner.
- D. The Manufacturer 's warranty period shall run concurrently with the Contractor 's warranty period. No exception to this provision shall be allowed.

1.11 PROJECT/SITE REQUIREMENTS

- A. Environmental Requirements: for dry pit application suitable for continuous duty operation under the following service conditions:
 - 1. Environment: Indoor raw wastewater pumping application involving occasional severe duty conditions.
 - 2. Area classification: Non-hazardous.
 - 3. Maximum ambient temperature: 40 degrees C.
 - 4. Altitude: up to 45 feet above MSL.

PART 2 PRODUCTS

2.01 GENERAL

- A. The pumping units required under this Section shall be complete including pumps, motors, and appurtenances with proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the work to be done. Ample room shall be provided for inspection, repairs, and adjustments.
- B. Each pump shall be provided with a steel baseplate. Baseplates shall be designed to be rigidly support the pumping units and shall be accurately anchored into position. All necessary anchor bolts, plates, nuts, and washers shall be furnished and installed by the Contractor in strict accordance with the Manufacturer's recommendations.
- C. Stainless steel nameplates giving the name of the manufacturer, the rated flow rate, head, speed, and all other pertinent data shall be permanently attached to each pump and/or motor. Additional stainless steel nameplates shall be provided to be installed by the Contractor on the VFD enclosures or other above grade location as instructed by the Engineer such that the pumps do not need to be removed to gather the information.
- D. The pumps shall be totally submersible, solids handling, rotodynamic pumps with submersible close coupled motors designed to pump raw, unscreened wastewater.

2.02 CONDITIONS OF OPERATION

- A. The pumps shall be as manufactured by Flygt (Xylem).
 - 1. The pumps for 118th Street MPS shall be NZ 3312/706 3~870, Station Capacity 17,200 gpm @ 64 ft-TH (3 of 4 pumps in operation).
 - 2. The pumps for Wilson Boulevard MPS shall be NZ 3231/615 380, Station Capacity 3,920 gpm @ 61 ft-TH (2 of 3 pumps in operation).
- B. Each pump shall be designed for the conditions of service tabulated as follows. All pumps with specific speed less than 4,500 (US units) shall have a continuously rising head performance curve for stable pump operation from the minimum head operating point to the shut-off head. For pumps where specific speed is greater than or equal to 4,500, the

intersection of the pump head and system head curves shall be used to demonstrate stable operation.

- C. The pumps shall operate throughout the entire operating range with the maximum vibration velocity in inches per second RMS unfiltered, measured in the field less than the requirements of ANSI/HI 11.6-latest edition.
- D. Each pump shall be designed for the conditions of operation tabulated as follows:

Item Description	Pump Design Conditions
Application	118 th St MPS
Manufacturer / Model	NZ 3312/706 3~870
Number of Pumps	4 (3 duty/1 standby)
Maximum Motor Full Load Speed (FLS) (rpm)	880
Maximum Allowable Motor (HP)	135
Motor Design Voltage/Phase/Frequency	460/3/60
Maximum Anticipated Pumped Fluid Temperature (deg F)	90
Minimum Pump Discharge Size (inches)	12
Minimum Pump Suction Size (inches)	14
Pump Telescoping Suction Connection (inches)	14x16
Minimum Pump Shut-Off Head at Motor FLS (feet)	120
Secondary TH (feet)	90
Minimum Flow Rate at Secondary TH (gpm)	2,500
Minimum Overall Efficiency at Secondary TH (%)*	60
Intermediate (Design) Flow Rate (gpm)	5,733
Minimum TH at Intermediate (Design) Flow Rate (feet)	64
Minimum Overall Efficiency at Intermediate (Design) Flow Rate (%)*	74
Minimum Overall Efficiency at Best Efficiency Point (%)*	81
Minimum Best Efficiency Point Flow Rate (gpm)	5,000
Minimum Best Efficiency Point TH (feet)	71
Primary TH (feet)	45
Minimum Flow Rate at Primary TH (gpm)	7,500
Minimum Overall Efficiency at Primary TH Flow Rate (%)*	60
Minimum Size Solids Passing (inches)	3
Maximum NPSH3 at Primary TH (feet)	25
Required Pump Speed Range (% FLS)	60-100

* Note that minimum overall efficiencies listed are “wire-to-water” in accordance with ANSI/HI 11.6 – latest edition.

Item Description	Pump Design Conditions
Application	Wilson Blvd MPS
Manufacturer / Model	NZ 3231/615 380
Number of Pumps	3 (2 duty/1 standby)
Maximum Motor Full Load Speed (FLS) (rpm)	1,185
Maximum Allowable Motor (HP)	90
Motor Design Voltage/Phase/Frequency	460/3/60

Maximum Anticipated Pumped Fluid Temperature (deg F)	90
Minimum Pump Discharge Size (inches)	8
Minimum Pump Suction Size (inches)	10
Pump Telescoping Suction Connection (inches)	8x10
Minimum Pump Shut-Off Head at Motor FLS (feet)	92
Secondary TH (feet)	73
Minimum Flow Rate at Secondary TH (gpm)	1,200
Minimum Overall Efficiency at Secondary TH (%)*	52
Intermediate (Design) Flow Rate (gpm)	1,942
Minimum TH at Intermediate (Design) Flow Rate (feet)	60
Minimum Overall Efficiency at Intermediate (Design) Flow Rate (%)*	62
Minimum Overall Efficiency at Best Efficiency Point (%)*	69%
Minimum Best Efficiency Point Flow Rate (gpm)	2,150
Minimum Best Efficiency Point TH (feet)	56
Primary TH (feet)	23
Minimum Flow Rate at Primary TH (gpm)	3,750
Minimum Overall Efficiency at Primary TH Flow Rate (%)*	35
Minimum Size Solids Passing (inches)	3
Maximum NPSH3 at Primary TH (feet)	24
Required Pump Speed Range (% FLS)	60-100

- E. Each pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to back flow through the pump.

2.03 PUMP CONSTRUCTION

- A. The overall pump design shall combine high efficiency, low required NPSH3, the ability to handle high solids concentrations effectively. The impeller/casing design shall result in a passage free of surfaces to which solid or fibrous materials can adhere and shall be capable of passing fibrous and nonwoven materials as found in domestic wastewater. The design shall permit low liquid velocities and gradual acceleration and change of flow direction of the pumped media.
- B. All external pump and motor parts shall be of close grained cast iron, ASTM A48 Class 35B construction, with all parts in contact with wastewater protected by corrosion resistant coatings. All external bolts and nuts shall be type 316 stainless steel.
- C. Impellers shall be constructed of ASTM A532 IIC hardened cast iron. Impellers shall be dynamically balanced.
- D. The impeller shall be a rotodynamic, a semi-open, solids handling type capable of passing solids either due to internal clearances or other features to facilitate solids processing including a wear plate with groove. The wear plate to impeller clearance shall be easily adjustable without the need for disassembly of the pump or the need to add or remove shims. The impeller may include pump out vanes on the upper shroud to reduce axial thrust and minimize clogging due to debris accumulation around the mechanical seal. The impeller shall be dynamically balanced to the ISO 1940 G6.3 standard to provide smooth, vibration free operation.

- E. A casing wear plate shall be installed to provide efficient sealing between the casing and the impeller. The wear plate shall consist of a stationary stainless steel plate installed in the lower half of the casing. Alternative materials and design approaches shall be as approved by the Engineer.
- F. Each pump shall be provided with a balanced tandem mechanical shaft seal system. The upper (inner) of the tandem set of seals shall operate in a seal lubricant chamber located just below the stator housing. At a minimum, this set shall contain one stationary silicon carbide and one positively driven rotating carbon ring and shall function as an independent secondary barrier between the pumped liquid and the stator housing. The lower (outer) of the tandem set of seals shall function as the primary barrier between the pumped liquid and the stator housing. This set shall consist of a stationary ring and a positively driven rotating ring, both of which shall be either tungsten carbide or silicon carbide. Each interface shall be held in contact by its own Hastelloy-C® or Elgiloy® spring system. The seal body shall be Type 316 stainless steel. The o-rings shall be FKM (Viton)®. The seals shall require neither maintenance or adjustment, but shall be easily inspected and replaceable. Seal design shall provide pressure applied to the outside diameter of the face. Shaft seals with conventional double mechanical seals containing either a common single or double spring acting between the upper and lower units are not acceptable nor equal to the dual independent seal specified.
- G. The minimum pump discharge size, shall be the minimum allowable nominal diameter of the discharge connection provided for attachment to the discharge piping, as shown on the Drawings, except as allowed otherwise by this specification. Unless otherwise noted, the diameter of the opening at the connection between the pump and the discharge should normally be the same as the minimum specified discharge size.
- H. The pump casing shall have a machined ASTM B16.1 125 lb flange connection to attach to the suction and discharge piping. The pump baseplate and sole plates shall be bolted to the concrete support base piers of the dry pit arrangement with Type 316 stainless steel J-type cast-in anchor bolts, monel nuts and accessories. The baseplate and associated accessories shall conform to the following:
 - 1. The baseplate shall be proportioned to support each entire pump/motor assembly and the loads (including the results of the dynamic analysis) to which it may be subjected during operation. It shall be properly supported on split sole plates and anchored and located as shown on the Drawings. Lifting lugs or eye bolts, special slings, strongbacks, or other devices necessary to handle the pump during loading, unloading, erection, installation, and subsequent disassembly and assembly shall be furnished.
 - 2. Sole plates shall be provided under each pump baseplate. The sole plates shall be installed, leveled and grouted in accordance with API RP 686, Chapter 5 – Mounting Plate Grouting. Jacking bolts and Five Star non-shrink epoxy grout as specified below shall be provided for leveling the baseplate assembly.
 - 3. An anchor bolt layout shall be provided to aid in placement of anchor bolts. All leveling jacking bolts shall be backed off after grouting so that they do not support any of the load.
 - 4. The grout for use in grouting under the sole plates supported by jack bolts (no shim stacks) shall be Five Star HP Epoxy Grout per specification 03600, Paragraph 2.02.B.1. or approved equal, mixed and applied according to the manufacturer's directions.

5. The presence of a Manufacturer' representative during the pouring of the epoxy grout as well as the use of rigid non-absorbing formwork and a head box are mandatory. The surface of the formwork in contact with the epoxy grout shall be covered with a layer of paste wax to facilitate removal. Clearance between the concrete surface and the bottom surfaces of the sole plates shall be per manufacturer's recommendation.
6. The concrete surface to be in contact with the epoxy grout shall be chipped to present a slightly rough surface and remove the laitance. The surface shall then be cleaned of all dust, moisture and oil. A thin layer of leveling grout shall be placed under metal discs that the jack bolts shall bear on. A one-inch minimum diameter by 1/4 inch thick stainless steel disk, with full radiused edges shall be placed under each jack bolt. All metal edges in contact with the epoxy grout shall be radiused to a minimum 1/2 inch radius in order to prevent stress risers in the epoxy grout. Plastic vent tubes, sized and spaced per manufacturer's recommendation, shall be placed under the sole plates to vent air during grouting and prevent voids in the epoxy grout.
7. The annular space between the anchor bolts and the anchor bolt sleeve shall be filled with expanding urethane foam. The threads of both the anchor bolts and jack bolts in contact with the grout shall be covered with paste wax and a layer of duct tape. After all alignment tolerances are met, the anchor bolts shall be tightened snug to prevent movement during the pour. The epoxy grout shall not be allowed to extend above the top edge of the sole plates. After the epoxy grout has fully cured, within 24 to 48 hours after pouring, the jack bolts shall be removed and the anchor bolts tightened to the torque levels as recommended by the Manufacturer.
8. The threaded jack bolt holes shall be coated with grease and the jack bolts cleaned of the paste wax and duct tape then reinserted and secured in position with a lock nut to within 1/4 inch of the bottom of the hole. After grouting, edges shall be chipped and patched to present a smooth finish.

2.04 SUBMERSIBLE MOTORS

- A. Pump motors shall be inverter duty rated, housed in an air filled, water-tight casing, and shall have Class F or better non-hygroscopic insulated windings which shall be moisture resistant. Oil filled motor housing are not acceptable. The motors shall be suitable for use with solid-state starters. The motor stator shall be dipped and baked three times in a VPI process and heat shrunk fitted into the stator housing. As an alternative, trickle impregnation method may be used for motor stator windings. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. Motors shall be NEMA Design B, equipped with a 1.15 service factor, as defined in the NEMA MG1 standard, based upon the nameplate horsepower rating for utility power service. A service factor of 1.0 will be acceptable when driven by a VFD (non-sinusoidal power supply). The motor insulation system shall be rated at 155°C or better. Motor shall be capable to operate in an ambient temperature of 40°C continuously with Class B temperature rise. The motor shall be NEMA Starting Code G or H, or better. Motors shall be non-overloading and capable of sustaining a minimum of ten starts per hour. Upper motor bearing shall be insulated. Motors shall be provided with a minimum power factor of 0.80 at full load. The motor efficiency shall comply

with the minimum required at full load to meet the wire-to-water efficiency specified in paragraph 2.02.

- B. Pump motors shall have cooling characteristics suitable to permit continuous operation in a non-submerged condition. Each motor shall incorporate three overheat sensing devices, one in each motor winding. These devices shall trip at 140°C. The sensing device shall be wired into the pump controls in a manner such that if the device operates, the pump will shut down. The temperature device shall be self-resetting.
- C. The pump motor shall incorporate a closed-loop cooling circuit with an integrated cooling pump rated for continuous duty in a completely dry mode; as well as; in a fully submerged condition without damage. The cooling jacket shall be cast iron ASTM A48 class 30 or steel. The coolant pump impeller shall be mounted directly on the motor shaft between the tandem mechanical seals to circulate coolant fluid into the top inter-space between the cooling jacket and motor housing, over the surface of the motor, through ducts in the bearing housing and into a casing heat exchanger. Heat losses from the motor shall be transferred to the fluid pumped in the casing heat exchanger, which forms a structural unit together with the discharge cover of the pump. After passing through the volute-casing heat exchanger, the coolant shall return to the suction side of the internal coolant pump (impeller). Coolant shall be an environmentally safe glycol based antifreeze or an environmentally safe food grade oil rated for use down to temperatures of minus 20°C (minus four degrees Fahrenheit).
- D. The pump/motor shaft shall be constructed of type 420 or type 431 stainless steel. When operating at the pump design point, the shaft shall have a maximum deflection of 0.2 mm at the lower seal face and a maximum deflection of 0.45 mm at the wear ring area. The shaft shall rotate on permanently lubricated ball bearings properly sized to withstand the axial and radial forces. The ABMA Minimum L-10 bearing life shall be at least 30,000 hours rated at the pump BEP.
- E. The pump motor with its appurtenances and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet. All mated surfaces shall be machined, fitted with O-rings for watertight sealing.
- F. The pumps shall be provided with a cable entry design that shall preclude specific torque requirements to insure a water tight and submersible seal. The cable entry shall be certified by UL or FM to have passed pull-testing requirements. The cable entry junction chamber and motor shall be separated by a stator lead, sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access to the pump motor top. The cable entry system shall be field serviceable. The power and control cable entry into the lead connection chamber may also be epoxy encapsulated for positive moisture sealing. A BUNA-N cable grommet shall be provided in addition to the epoxy sealed leads.
- G. Cables, Conduits and Accessories
 - 1. The pumps shall be supplied with power and sensor conductors. Pump motor cables shall be sized to meet applicable NEC requirements. The cable shall consist of a type SPC or SEOW insulated cable with a double jacketed protection system. The cable shall have a neoprene or chlorinated polyethylene outside and synthetic rubber inside, and shall exceed industry standards for oil, gas and sewage resistance. Individual conductors shall be of type RUW. Pump cables shall be provided of sufficient length so that the cables will be continuous between the pump and the disconnect with no splices being allowed.

2. If more than one cable is being provided per pump, the Contractor shall furnish and provide for the installation of the additional conduits, etc. as required for each additional cable. Only one cable per conduit will be allowed at the pump station. Conduit sized per manufacturers recommendations but not smaller than 3/4-inch.
3. Contractor shall furnish all required stainless steel conduit hardware and fittings.
4. Water tight connectors shall be equal to Crouse-Hinds Type "CGB", with neoprene lands shall be furnished with and installed in the control panel enclosure or disconnect to terminate each conduit and seal each cable entry.
5. Conduit seals shall be equal to Crouse-Hinds Type "EYS".
6. Coordinate the installation of the above materials with the Manufacturer.

2.05 VARIABLE FREQUENCY DRIVES

- A. The speed control for variable speed pumps shall be Variable Frequency Drives, as specified in JEA's Water & Wastewater Standard's Manual (January 1, 2020) edition and in Section 262923 Variable Frequency Motor Controllers, suitable for installation as shown on the Drawings.
- B. The Variable Frequency Drives shall be supplied by the Manufacturer and shall be completely coordinated with the pumps and pump driving motors and shall include all internal auxiliaries required to meet the functional specifications.
- C. The Variable Frequency Drives shall conform to all requirements stipulated in this Section and JEA's Wastewater Standard's Manual (January 1, 2020) edition and in Division 26 Electrical, and shall be designed for a speed range of 30% to 100% of full load motor speed.
- D. The Variable Frequency Drives shall be compatible with the motors provided by the Manufacturer.

2.06 PUMP/MOTOR PROTECTION SYSTEM/PANEL

- A. A pump/motor protection system shall be provided to monitor machine vibration, temperature, and moisture. The system shall provide warning and shutdown protection and shall be UL listed. All of the pump/motor unit protective and monitoring sensors shall be connected to an electronic module which will provide a signal from the pump/motor sensors to the devices located in the pump/motor protection panel. Modules shall be as manufactured by Benshaw, or the pump Manufacturer.
- B. Detailed operational data shall be accessible using a standard web browser on a computer with no special software required. Alternatively, data shall be capable of easily being transferred to a higher level distributed control system such as a Supervisory Control and Data Acquisition (SCADA) system.
- C. The pump/motor protection system shall monitor each pump/motor's temperature, vibration and moisture (leakage). The system shall be provided with Ethernet, Modbus and modem communications ports, and shall be capable of communicating with the SCADA system. Provide relay outputs for remote monitoring of warning and alarm.

- D. The pump/motor protection panel shall be mounted on the dead-front panel. The pump/motor protection panel shall include soft-touch type navigation keypad, alarm acknowledgement keypad, amber warning lamp, red alarm lamp and a LCD digital display. The digital display shall provide the local readout of pump/motor sensor and alarm status and aid in navigation through the system during set-up.
- E. Each pump/motor unit(s) shall be equipped with the following protection and monitoring sensors:
1. Three motor winding bi-metallic thermal switches or thermistors, one installed in each motor stator phase winding, and connected in series to monitor and protect the winding from over temperature operation. The thermal switches shall open, activating an alarm and stopping the motor should a high temperature event occur.
 2. One PT-100 (Platinum, 100 ohm, 2 or 3-wire) temperature probe shall be installed in the bearing housing holding the outer race of the thrust bearing and lower support bearing to provide for accurate temperature monitoring of the bearings.
 3. Three PT-100 (Platinum, 100 ohm, 2 or 3-wire) temperature probes, one installed in each motor stator phase winding, to provide direct stator temperature read-out of each phase winding.
 4. One PT-100 (Platinum, 100 ohm, 2 or 3-wire) temperature probe shall be installed in the bearing housing holding the outer race of the upper support bearing to provide for accurate temperature monitoring of the bearing.
 5. One Float-type Moisture (Leakage) Sensor (Stator FLS) shall be provided to detect water intrusion into the motor stator chamber. If activated, the FLS will activate an alarm.
 6. One Float-type Moisture (Leakage) Sensor (Electrical Connection FLS) shall be provided to detect water intrusion into the motor electrical connection (cable junction) chamber. If activated, the FLS will activate an alarm.
 7. One water-in-oil or water-in-air capacitive type moisture sensor installed in the mechanical seal lubrication chamber (between the inner and outer mechanical seals) to alarm should there be intrusion of water into the chamber.
 8. One vibration sensor shall be installed in the power cable junction chamber of the pump/motor unit. The vibration sensor shall be capable of monitoring vibration velocity in in/sec RMS unfiltered. Alternatively, one vibration sensor shall be installed to the outside of the pump casing near the upper bearing housing in accordance with manufacturer's recommendations. A separate sensor mounting base equipped with mounting stud shall be connected to the pump with epoxy-based adhesive, to which the sensor shall be mounted. Sensor (accelerometer) shall be model SA6200UW as manufactured by Metrix or equal. Provide associated model 5535 signal conditioner/transmitter as manufactured by Metrix or equal to be mounted in the pump/motor protection panel.
 9. All relays associated with the monitoring and protective devices furnished.

2.07 PRESSURE GAUGES

- A. See Division 13 Instrumentation specifications for pressure gauge requirements.

2.08 SHOP PAINTING

- A. Each pump and associated equipment shall be shop-primed and finished-coated in accordance with the Manufacturer's standard practice prior to shipment. Color shall be selected by the Engineer and an adequate supply of touch-up paint shall be supplied by the Manufacturer.
- B. All interior and exterior wetted surfaces of pumps, exterior and interior of cooling jacket and exterior of motor enclosure shall be thoroughly cleaned, dry and free of all rust, mill scale, grease, dirt, other foreign matter and supplied with Manufacturer's standard coatings meeting the requirements in Sections 09901 and 09902.
- C. All nameplates shall be properly protected during painting.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation shall be in strict accordance with the Manufacturer's instructions and recommendations in the locations shown on the Drawings. The Contractor shall furnish all required oil and grease for initial operation, if required, in accordance with the Manufacturer's recommendations. Anchor bolts shall be set in accordance with the Manufacturer's recommendations.
- B. Upon completion of each pump installation, the Manufacturer shall inspect the unit and submit a certificate stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.02 INSPECTION AND TESTING

- A. General
 - 1. The Engineer shall be notified in writing prior to initial shipment and/or testing, in ample time so that arrangements can be made for inspection by the Engineer.
 - 2. Field tests shall not be conducted until such time that the pumping system, including controls, is complete and ready for testing.
- B. Factory Pump Test
 - 1. All pumps shall receive a non-witness factory test.
 - 2. The Manufacturer shall factory test all pumps prior to shipment in accordance with the Hydraulic Institute standards, latest version. Flow rate, total head and Input KW shall be tested and recorded for at least five points on the pump performance curve. Test shall be performed to demonstrate that the pumps meet ANSI/HI 11.6 acceptance grade 1U for all specified points. The five points shall include the points specified in pump performance table in Paragraph 2.02.

3. The Manufacturer shall perform hydrostatic test on the pressure-containing parts in accordance with ANSI/HI 11.6. Test shall be conducted on each pump prior to final coating and shipment.
4. The Manufacturer shall perform the following test on each pump prior to shipment from factory:
 - a. Megger motor and pump for insulation breaks or moisture.
 - b. Prior to submergence, the pump shall be run dry and checked for correct rotation.
 - c. Pump shall be run for a minimum of 30 minutes in a submerged condition.
 - d. The pump shall be removed from test tank, meggered immediately for moisture and upper and lower seal unit shall be checked for water intrusion.
 - e. A written certification test report regarding the above tests shall be submitted for approval prior to shipment.

C. Field Pump Test

1. As specified in Paragraph 1.07 B., the Manufacturer shall furnish the services of a representative who shall have complete knowledge of proper operation and maintenance to inspect the final installation and supervise the test run of the equipment. The Manufacturer shall include in his price, a minimum of eight hours of a representative's time for the above tests.
2. Written test procedures shall be submitted to the Engineer for approval 30 days prior to testing.
3. The Contractor shall furnish all water, power, facilities, labor, materials, supplies and test instruments required to conduct the field testing.
4. The Final Acceptance Test shall demonstrate that all items of these Specifications have been met by the equipment as installed and shall include, but not be limited to, the following tests:
 - a. That all units have been properly installed and are in correct alignment.
 - b. The Contractor shall check for correct lubrication in accordance with manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections, if necessary.
 - c. That the units operate without overheating or overloading any parts and without objectionable vibration.
 - d. That there are no mechanical defects in any of the parts.
 - e. That the pumps can deliver the specified total head and flow rate to demonstrate that the pumps generally meet the requirements specified (factory performance test is the basis of pump acceptance).
 - f. That the pump sensors and controls perform satisfactorily as to sequence control, correct start and stop elevations, and proper level alarm functions.
5. If the pump performance does not meet the specifications, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified.
6. A five-day continuous operating period of the pumps will be required before acceptance. If pumping system fails during the test period, the test shall be restarted (including reset of time to zero) after repair (or replacement) has been completed.

D. Field Vibration Testing

1. After installation and as soon as conditions permit full speed operation, and in the presence of the Engineer, have the vibration tests performed in accordance with ANSI/HI 11.6 on each unit by a minimum level III qualified vibration technician as defined by Vibration Institute or equivalent to (a) prove compliance with specified limitations, and (b) prove that there are no field installed resonant conditions due to misalignment, the foundation, or the connecting piping and its supports, when operating at any speed within the specified operating range.
 - a. At a minimum, if pump system is furnished with vibration and temperature monitoring system, the motor lower vibration sensors may be used for acceptance testing. Alternatively, temporary surface mounted sensors mounted in the vicinity of the installed sensors are preferred to additionally establish the accuracy of the permanently installed system.
2. If required, take corrective action and the units shall be retested to ensure full compliance with this Section. All costs associated with the field tests or any required corrective action shall be borne by the Contractor.

END OF SECTION

SECTION 443133 - ODOR CONTROL BIOSCRUBBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Details for an odor control bioscrubbing system, including vessel, fan, electrical and irrigation controls, interconnecting ductwork between the scrubber vessel and the fan.
- B. Furnish labor, materials, equipment and incidentals required for the installation, startup, warranty and testing of the complete, fully functioning bioscrubber system as shown on the Drawings and as specified.
- C. Furnish installation, commissioning, training, and performance testing to provide a complete functioning system with full warrantee coverage as described in this section.
- D. System Include:
 - 1. Fiberglass reinforced plastic (FRP) bioscrubber system including:
 - a. FRP scrubber vessel
 - b. Fan
 - c. Exhaust stack
 - d. Media.
 - e. Mist eliminator.
 - f. Interconnecting ductwork to the fan
 - g. Balancing Damper
 - h. Isolation damper
 - i. Local control panel.
 - j. All interconnecting wiring and controls
 - k. Automatic irrigation control panel
 - l. Nutrient storage tank.
 - m. Local Control Panel.
 - n. All items as shown on the Drawings and as specified, and as required for a fully functioning system.
- E. Contractor's Responsibilities:
 - 1. Install a fully functioning system and coordinate with bioscrubber manufacturer to meet requirements specified and shown on the Drawings.
 - 2. Furnish proper functioning internal piping and appurtenances.
 - 3. Furnish water, drain and interconnect piping.

4. Furnish connecting ductwork.
 5. Power and control wiring to bioscrubber system, including power and control wiring between the bioscrubber electrical control panel and the water panel.
 6. The manufacturer to furnish and be responsible for integral electrical components i.e. transformers, control panels and circuits, interlocks, instrumentation, etc. required for proper functioning of the system.
- F. This Specification gives a general description of system requirements, but does not cover all details, which will vary depending on manufacturer and requirements of application. It does cover the furnishing, delivery, installation supervision, startup, warranty, and field testing of materials, equipment and appurtenances for a complete bioscrubber system as specified, whether specifically mentioned in this Section or not.
- G. Related Requirements:
1. Division 3, "Concrete" for concrete requirements as required for this Section.
 2. Section 055000, "Metal Fabrications" for fasteners, brackets, and other miscellaneous metal fabrications as required by this Section.
 3. Section 099010, "Shop Priming" for surface preparation and shop painting for equipment specified in this section.
 4. Section 230593, "Testing, Adjusting, and Balancing for HVAC" for air balancing of odor control system.
 5. Section 233116, "Nonmetal Ducts" and 233300, "Air Duct Accessories" for interconnecting ductwork, dampers, and accessories as specified in this Section.
 6. Section 261923, "Medium Voltage Variable Frequency Motor Controllers" for variable frequency controllers.
 7. Division 26, "Electrical" for electrical requirements as required for this Section.
 8. Division 40, "Piping" for piping requirements as required for this Section.
 9. Division 40, "Instrumentation" for instrumentation requirements as required for this Section.
 10. Section 400593.13, "Medium-Voltage Motor Requirements for Process Equipment."
 11. Section 400593.23, "Low-Voltage Motor Requirements for Process Equipment."
 12. Section 400557, "Actuators for Process Valves and Gates" for damper actuator requirements. For 120 volt power actuators.
 13. Section 431119, "Centrifugal Fans" for odor control fans.

1.3 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. H₂S: Hydrogen Sulfide.
- C. Manufacturer: The term "manufacturer" as used in this specification will refer to the manufacturer of the bioscrubber system or the manufacturer's authorized representative.
- D. OIT: Operator interface terminal.
- E. PLC: Programmable Logic Controller.
- F. scfm: Standard cubic feet per minute.

G. ppm: Parts per million.

1.4 ACTION SUBMITTALS

A. Section 013300, "Submittal Procedures" for submittals requirements.

B. Product Data:

1. Manufacturer information for system materials and component equipment.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. Scrubber Design and Operation Information: Performance criteria as specified in "Performance and Design Criteria" Paragraph in the Bioscrubbers" Article in PART 2.
4. Nozzle Data: Construction details, water distribution pattern, and attachment to vessel.
5. Media Data Including, but not Limited to the Following:
 - a. Media physical characteristics.
 - b. Media layout and supports.
 - c. Descriptive information of packing media
 - d. Media replacement instructions.
6. Complete data on the headloss for air flow through the vessels (including media, and exhaust stack) at design air flow rate, including initial and maximum.
7. Materials of Construction: FRP resin and glass
8. Details of Vessel Construction:
 - a. Include thickness of each layer.
 - b. Glass fiber type and percent by weight.
 - c. Resin type and percent by weight..
 - d. Signed statement from manufacturer that materials and resins used are suitable for the intended service.
9. **Fan Data Sheets: As required in Section 431119.**
10. Recirculation Pump: Data sheets with a description of proposed pump, pump size, type, performance curve, dimensional data, materials of construction, weight, motor horsepower, efficiency, motor type, power supply, anchor bolt locations and requirements, and accessories.
11. Instrumentation data.
12. Complete operating description and programming control narratives, and a detailed list of inputs/outputs (I/O) wired to supplied control panel.
13. Electrical wiring diagrams.
14. Complete description and data of surface preparation and shop prime painting.
15. Instrumentation, control, logic and power wiring diagrams. Enough detail to allow installation of the instrumentation, controls, and electrical components. Include the following:
 - a. Panel heat load calculations.

C. Shop Drawings:

1. Certified shop and erection drawings including important details of construction and dimensions for entire system, including fans, dampers, inlet duct manifolds, duct supports on the equipment pad, control panels, pumps, storage tanks, and interconnecting piping.
2. Operating weight of all equipment.
3. Installation and anchoring requirements, fasteners, and other details.
4. Foul air duct, drainage piping, and layouts and dimensions.
5. Control panel, water panel and instrument interior layouts and dimensions.
6. Process and piping diagram, with instrumentation list, cut sheets, and spare parts list.
7. Bill of Materials for equipment.
8. Spare parts list.
9. Special tools list.
10. Enough information to allow Engineer to check clearances, connections, and conformance with the specifications.

D. Samples for Verification:

1. Engineer may instruct to extract a 1-inch diameter sample from vessel for resin analysis.
 - a. Provide sample from vessel cut during fabrication.
 - b. Exact Location of Test Sample: Submitted by manufacturer for Engineer's review and approval.
 - c. Hole to be repaired by the manufacturer.
 - d. Analysis: Paid for by the manufacturer.
 - e. The Engineer may reject the vessel if it does not meet the standard if the resin type or construction of the representative samples.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Products meet or exceed specified requirements.

1. Statement from the resin and vessel manufacturer that materials and resin meet specifications stipulated in this section and are suitable for this installation including UV, acid, and corrosivity resistance.
2. Statement from the pump manufacturer(s) that materials are suitable for pumping low-pH liquid and for this installation including UV and corrosivity resistance.
3. Statement that all equipment and materials are appropriate for an outdoor and corrosive environment at wastewater treatment facility. Materials that are not corrosion resistant (e.g. carbon steel) are not permitted.
4. Statement that all materials are appropriate for the fluids/streams that they encounter.
5. A list of non-conforming aspects of this specification, with clear reasoning for deviation, requiring Engineer approval prior to equipment fabrication or ordering materials.
6. Any revision during the submittal phase to meet the specification will come at no additional cost to the Owner.

B. Submit P.E. Certification Form as required under PART 2 of this Section.

C. Manufacturer Instructions: Detailed instructions on installation requirements, including storage, lifting, and handling procedures.

- D. Mechanical Commissioning and Start-up, acclimation procedures and the layout for temporary piping required during the acclimation period.
- E. Source Quality-Control Submittals: Plans and results of factory tests and inspections.
- F. Field Quality-Control Submittals: Plans and results of Contractor-furnished tests and inspections.
- G. Manufacturer Reports: Certify equipment is installed according to manufacturer instructions. Statement will include the following:
 - 1. Installation of equipment is satisfactory.
 - 2. Units are satisfactorily tested, and ready for operation.
 - 3. Operating personnel have been suitably instructed in the operation and care of the units.
- H. Qualifications Statements:
 - 1. Qualifications for manufacturer, installer, and licensed professional.
 - 2. Manufacturer's approval of installer.
- I. Operation and Maintenance Data in accordance with Section 017823.

1.6 DELEGATED DESIGN SUBMITTAL

- A. Delegated Design Submittals: Licensed Florida P.E. signed and sealed detailed dimensional Shop Drawings with design calculations and assumptions including the following.
 - 1. Scrubber vessel construction, hold down lugs, anchoring, bracket and vessel flange thicknesses, scrubber vessel anchor size requirements and locations where anchor bolts must be placed.
 - 2. Scrubber vessel, stacks, and applicable appurtenances can withstand the wind load and live load design criteria specified herein.
 - 3. Complete description of surface preparation and shop prime painting.

1.7 CLOSEOUT SUBMITTALS

- A. Section 017700 "Closeout Procedures" for closeout submittals requirements.
- B. Equipment start-up and training documents for approval prior to commissioning.
 - 1. Mechanical commissioning procedures.
 - 2. Acclimation procedures.
 - 3. Training program.
 - 4. Performance testing protocol.
 - 5. Reports as listed under "Informational Submittals" Article in PART 1.
- C. Project Record Documents: Record actual locations of installed biofilters.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Section 017700, "Closeout Procedures" for maintenance materials requirements.
 - B. Spare Parts:
 - 1. Nutrient Metering Pump:
 - a. Diaphragm Assemblies: One.
 - b. Check Valve Assemblies Consisting of Check Valves, Valve Seats, and Gaskets:
 - 2. Each Recirculation Pump:
 - a. One replacement pump
 - 3. Scrubber:
 - a. Gaskets for Gasketed Covers and Connections: One set.
 - b. Spray Nozzles: One Set.
 - 4. Instrumentation:
 - a. Surge Protectors: One for each type and voltage provided.
 - b. Pressure Transmitter: One replacement pressure transmitter.
 - 5. Control Panel Spare Parts:
 - a. Timers and Sockets: One of each type installed.
 - b. Relays and Sockets: One of each type installed.
 - c. Fuses and Circuit Breakers: One of each type
 - d. Light Bulbs: One of each type
 - C. Pack spare parts in sturdy containers with clear indelible identification markings, referencing the equipment that they are intended for, and will be stored in a dry, warm location until transferred to the Owner at the conclusion of the project. Provide complete ordering information including manufacturer, part number, part name and equipment for each part to be used.
 - D. Manufacturer will furnish special tools that are required to assemble, disassemble, repair, and maintain any item of mechanical equipment, with respective equipment. Special tools will include any type of tool that has been specifically made for use on an item of equipment for assembly, disassembly, repair, and maintenance. When special tools are provided, they will be marked or tagged, and a list of such tools will be included with maintenance and operation instructions describing use of each marked tool. Additional requirements will be included with individual items of equipment.
- ## 1.9 QUALITY ASSURANCE
- A. Perform Work according to JEA standards.
 - B. Maintain a copy of each standard affecting Work of this Section on Site.

1.10 QUALIFICATIONS

- A. Equipment provided, designed and furnished by a single manufacturer fully experienced, reputable and qualified in system and equipment specified. This Specification calls attention to certain features but does not purport to cover all details entering into the design and construction of the equipment.
 - 1. Equipment offered may differ from what is specified if approved by the Engineer to be equivalent in performance.
 - a. Any revision in design or construction to accommodate equipment offered will be made at no additional cost to the Owner and approved by the Engineer.
- B. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience fabricating substantially similar equipment using the same media and irrigation system specified herein.
- C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Florida.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000, "Product Requirements" for transporting, handling, storing, and protecting products requirements.
- B. Deliver materials in coordination with installation of the pad, wiring, and piping by others. Contractor is responsible for ensuring that equipment is delivered after the installation of the pad.
- C. Exercise care during loading, transporting, unloading, and handling to prevent damage of any nature to interior and exterior surfaces of pipe and fittings. Do not drop pipe and fittings. All equipment and materials to be properly protected and maintained such that no damage will occur from the time of shipment until the completion of the installation.
- D. Ship vessel in the vertical or horizontal position. Multiple shipments are acceptable.
 - 1. Manufacturer is responsible for any damage to the shape of the unit.
 - 2. Contractor must orient the vessel vertically upon offloading the vessel.
 - 3. Lifting lugs (minimum of three) provided for use in transporting and placing the vessel.
- E. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage. Equipment to be inspected and accepted by Owner and Contractor before unloading at installation site.
- F. Store materials on the project site in enclosures or under protective coverings in accordance with manufacturer's recommendations and as required by the Engineer.
- G. Protection: Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 1. Position the equipment as required by the Manufacturer.

2. Provide additional protection according to manufacturer instructions.

1.12 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Document field measurements on Shop Drawings.

1.13 WARRANTY

A. **Section 017700**, “Closeout Procedures” for warranties requirements.

B. Furnish two-year manufacturer's warranty for bioscrubber system and accessories.

1. Vessel Degradation: As a result, corrosion or UV barrier failure. Structural failure (cracking) of flanged connections or connections of hold down lugs.

C. The Manufacturer must warrant the suitability of the biological reactor media for a period of 10 years, if system is operated in accordance with the manufacturer’s Operation and Maintenance Manual. In the event of a failure of the media within the 10-year warranty period, the manufacturer will replace the media at no expense to the Owner or Contractor and the 10-year warranty reinstated for the replacement media.

1. Media Failure: As a result of compaction and/or fouling resulting in pressure drop in excess **of 4 times** the pressure drop at start-up. Diminished performance as a result of preferential pathways developing in the media (channeling).

PART 2 - PRODUCTS

2.1 BIOSCRUBBERS

A. Heyward Florida Incorporated HIBOCS-600 was used as the basis of design for the bioscrubber system. Approved Manufacturers are as follows:

1. Heyward Florida Incorporated.
2. BioAir Solutions.
3. Evoqua Water Technologies.
4. KCH Services, Inc.

B. Description:

1. Bioscrubber System: Continuously and automatically treat and effectively remove hydrogen sulfide, and eliminate odors in the air exhausted from the pump station influent chamber and wetwell as shown on the Drawings and as specified. Odorants are removed by microbial action within media in the bioscrubbers.
2. Type: Vertical tower including media, irrigation system, fan, pump, controls, ductwork, etc.

3. Operating Condition: Pressure.

C. Performance and Design Criteria:

1. Scrubber system to meet all applicable OSHA and local safety requirements.
2. Total Air Flow Rate: 1,600 scfm
3. No. of Parallel Vessels: One.
4. Capacity per Train: 1,600 scfm
5. Maximum Pressure Drop from odor control fan to outlet stack: 5-inch wg.
6. Minimum Empty Bed Residence Time (EBRT): 20 seconds.
7. Hydrogen Sulfide Concentration (Single System):
 - a. Average Inlet: 200 ppm.
 - b. Peak Inlet: 400 ppm.
 - c. Outlet: Average hydrogen sulfide removal efficiency to be equal to or greater than 99 percent over a test period that includes both average and peak conditions OR average outlet H₂S concentration not to exceed 0.5 ppm, whichever is less stringent.

***** [OR] *****
***** [OR] *****
8. Components of system must be compatible with the conditions and constituents to which they will be subjected to during normal operation. Compounds with which the materials of construction must be compatible with include, but are not limited to:
 - a. Hydrogen Sulfide.
 - b. Sulfuric Acid.
 - c. Bioscrubber system to be able to re-acclimate after upset conditions within a period of three weeks.
9. Ambient Temperature: 28 degree to 105 degrees F
10. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
11. Irrigation and water requirements as specified below.
12. Dimensional and weight requirements as specified below.
13. Seismic requirements as specified herein.
14. Manufacturer is responsible for providing a fully functioning system as required under the environmental conditions specified.
15. Any additional equipment will come at no additional cost to the Owner.

D. Irrigation:

1. Total Instantaneous Maximum Water Flow Rate Available: 4.2 gpm .
2. Total System Water Consumption: 6,000 gallons/day.
3. Available Water Pressure: 70 psi at the water panel
 - a. Contractor to confirm existing plant pressure conditions. If water pressure conditions are not sufficient for bioscrubber system, manufacturer will provide a booster pump at no additional cost to Owner.
4. Water Quality:

- a. Total Chlorine: <2 mg/L.
 - b. Hardness: 200 mg/L.
 - c. Total Suspended Solids: <5 mg/L.
 - d. Total Kjeldahl Nitrogen: 1 to 2.5 mg/L.
 - e. Total Phosphorus: **0.1 to 2** mg/L.
5. Contractor to confirm water quality and pressure conditions with manufacturer prior to ordering of materials and system fabrication.
- a. Manufacturer is responsible for providing a fully functioning system as required using the service water available.
 - b. Any additional equipment will come at no additional cost to the Owner.
 - c. Any revision in layout will require approval by the Engineer.

E. Nutrients:

1. Nutrient Tank: FRP construction suitable for outdoor conditions. Construct to same standards as the vessel and have hold-down lugs calculated to secure the tank during high wind conditions.

F. Vessel:

1. **Maximum Diameter: 10 ft.**
2. **Maximum Vessel Straight Wall Height (not including stack): 16 ft (4.6 m).]**
***** [OR] *****
3. Maximum Vessel Operating Weight: **5,000 lb .**
4. Structural Requirements:
 - a. Roof Live Load: 20 psf uniform.
 - b. Design wind speed as listed on the structural drawings.
 - c. Minimum Wall Thickness: Per structural calculations but no less than **3/8 inch** for all vessels.
 - 1) External circumferential reinforcing ribs and bottom knuckle reinforcement as dictated by the design and ASTM D3567.
 - a) Knuckle: Seamless having a minimum radius of 1-1/2 inch.
 - 2) Flat Bottom of Rectangular and Cylindrical Vessels: Constructed integral to the straight sides off of a singular mold with no seams.
 - 3) Laminating flat bottom to vertical sides will not be accepted.
 - d. Minimum Structural Safety Factor: Pressure: 10:1.
***** [OR] *****
5. Fiberglass Reinforced Plastic Vessel: All parts of vessel proportioned to have liberal strength and stiffness and especially adapted for work to be done.
 - a. Ample Room and Facilities: Provided for access.
 - b. Designed to support required number of media layers and treatment stages.
 - c. Reactor Vessel: Constructed of corrosion resistant, UV resistant fiberglass reinforced plastic.

- d. All materials of construction to be corrosion resistant, including any non-FRP components.
 - 1) Treat Vessel interior with vinyl ester corrosion barrier for maximum corrosion resistance.
 - 2) Vessel Exterior: Incorporate a surface veil for superior durability.
- e. Equipment to meet the following requirements:
 - 1) ASTM D3299 for filament wound tanks.
 - 2) ASTM D4097 for contact molded tanks.
 - 3) ASTM 3982 for contact molded duct.
- f. Resins: Factory-fabricated fiberglass-reinforced resin used to be resistant to corrosion by wet hydrogen sulfide and other corrosive gases present in wastewater treatment plants.
 - 1) A single fire-retardant resin is to be used throughout.
 - 2) Flame Spread Ratio: 25 maximum, when tested in a Steiner Test Tunnel per ASTM E84.
 - 3) Antimony or NYACOL additives are not to be used to achieve flame spread index.
 - 4) Acceptable products:
 - a) Derakane 510-B-400.
 - b) Cor VE 8401.
 - c) AOC Vipel K022.
 - d) Reichold's Dion Impact 9303-54: Hetron 998-35.
- g. Shell: An interior layer, a corrosion barrier, a structural layer and an exterior layer.
 - 1) Interior Layer: Minimum 20 mil thick single-layer Nexus or C-glass surface veiling in a resin rich surface.
 - a) Resin Content: Approximately 90 percent.
 - 2) Corrosion Barrier: Minimum thick Type E glass strand mat, applied in two layers of equal thickeners.
 - a) Resin Content: Approximately 70 percent.
 - b) No thixotropic agents may be used in the corrosion barrier.
 - 3) Structural Layer: Alternating layers of Type E glass, reinforced by interweaving of chopped strand mat and woven roving continuous helically filament winding glass.
 - a) Resin Content: Approximately 60 percent.
 - b) Chemically resistant construction suitable for the service, providing the additional strength necessary to meet the tensile and flexural requirements.

- c) Where separate layers such as matt, cloth, or woven roving are used, layers must be lapped a minimum of 1 inch.
 - d) Laps: Staggered as much as possible.
 - e) If woven roving or cloth is used, the layer of chopped strand glass must be placed as alternate layers.
 - f) Filament Wound Structural Layers: Per ASTM D2996.
 - g) Handwork is acceptable, but enough resin must be present to prevent fiber show.
- 4) Reinforcing Material: Commercial grade glass fiber containing a coupling agent to produce a suitable bond with the resin used.
- 5) Exterior Layer: Paraffinated gel coat with UV inhibitors. There is to be no pigmentation added to the exterior layer.
- h. All Surfaces: Finished to obtain complete cure of resin without air inhibition.
 - 1) Finished Laminate: Free as commercially practicable from visual defects; foreign inclusions, dry spots, air bubbles, pinholes and pimples.
 - 2) Post cure vessel per resin manufacturer's recommendations and conform to resin manufacturer's minimum standard for Barcol hardness.
- i. Inner Surface:
 - 1) Interior layer to meet visual acceptance criteria in Table 5 ASTM C582 process side.
 - 2) Free of cracks and crazing with a smooth finish.
- j. Exterior Surface:
 - 1) Meet the referenced criteria for the non-process side.
 - 2) Relatively smooth with no exposed fibers or sharp projections.
- k. Any Grinding, Repair, or Sanding of Interior Surfaces: Covered with a laminate duplicating the inner corrosion liner and paraffinated topcoat.
- l. Exposed Edges: Sealed with same resin as used on vessel and be fully post cured.
- m. No longitudinal joints in axial direction of the cylindrical shell.
- n. Entire Shell Thickness: Built up prior to removal of the shell from the mandrel.
- 6. Hold-Downs (minimum of four): Consisting of fiberglass-reinforced polyester gusseted hold-down lug laminated to vessel sidewall with a Type 316L stainless steel anchor clip.
 - a. Use anchor clip for anchor bolting to the concrete foundation and clamping to the hold-down lug.
 - 1) Hold-Down Systems: Sufficient strength to hold vessel and any exhaust duct the vessel supports against all loads.
 - b. Vessel manufacturer to provide to the Contractor, anchor requirements and locations where anchor bolts must be in place when the support pad is poured.
 - c. Anchor bolts to be provided by the Contractor.

- d. Piping, Instrumentation, and Ductwork Connections: As indicated on Drawings and as specified.
 - 1) Sump high and low level switch
 - e. Piping Supports: As indicated on Drawings and as specified.
- G. Flange Nozzles and Accessways: Flanges compatible with connecting piping and duct work.
- 1. Comply with ASTM D3299 and ASTM D3982.
 - 2. Liquid nozzles: ANSI Class 150 rated flanged nozzles.
 - a. Press molded, or compression molded flanged nozzles will not be accepted.
 - b. Nozzles 6 inch Diameter and Smaller: Blade gusseted configuration meeting strength requirements of 1500 ft-lbs of bending and 2000 ft-lbs torque.
 - 3. Flanges: Manufactured by hand lay-up method and conform to ANSI Class 150 standard dimensions for bolting.
 - a. Area on the Back of All Flanges Around Bolt Holes: The diameter of a standard washer, flat and parallel to the flange face. Spot face, if necessary, to meet this requirement.
 - 4. Blind Flanges and Access Doors: The same thickness and material as flanges to which they are attached. Flatness tolerances to be the same as for flanges.
 - 5. Manway and Duct Flanges: Per ASTM 3982
 - 6. Access Doors and Bolted Attachments:
 - a. Provided with 1/8 inch thick EPDM gaskets and 316 stainless steel nuts, bolts and washers.
 - b. Construct Access doors of industrial grade, clear polycarbonate that will not structurally deteriorate or cloud. Thickness: 1/2 inch minimum.
 - 7. Supports: Suitably attached to outer vessel walls as necessary supporting vessel piping and interconnecting FRP ductwork. Meet loading criteria as specified.
 - 8. Threaded Couplings: Not allowed below the liquid level.
- H. Exhaust Stack Mist Eliminator: Capable of removing greater than 99 percent of droplets 10 microns in diameter and larger at design air flow rate.
- 1. Minimum Depth: 6 inches.
 - 2. Quick connect for access and cleaning mist eliminator.
 - 3. Materials:
 - a. Mesh: Polyethylene (PE).
 - b. Supports: FRP.
- I. Spray Nozzles: The reactor vessel to be configured with sufficient fluid spray nozzles to provide sufficient and well distributed irrigation.
- 1. Type: Full cone.
 - 2. Material: 316 stainless steel.

J. Exhaust Sample:

1. Locate exhaust sample location and necessary fittings as shown on the Drawings.
2. Sample Pipe: 1/4 inch exhaust sample polyethylene tubing inside the 3/4 inch PVC pipe that is connected to the exhaust stack.
 - a. The 3/4 inch port to have an internal air trap ensuring that when open, the polyethylene sample connection will capture free-flowing air.
 - b. Manufacturer to provide supports for along the vessel for exhaust sample as shown on the Drawings.

K. Synthetic Media:

1. Media: Structured or random synthetic, chemically resistant and able to withstand the foul air characteristics specified, for the life of the media.
 - a. Designed to not foul or plug and be resistant to shrinking or swelling with varying moisture content.
2. Organic Media and Non-Synthetic Inorganic Media: Not to be allowed.
3. Media Layers: Easily removable single media sections or randomly dumped.
 - a. Treatment Layers: Designed not to short circuit, collapse, or be subject to channeling under operating conditions.
4. Manufacturer is responsible for providing the minimum media to comply with the minimum residence time specified and to ensure system meets specified performance.

L. Level switch to monitor sump water level

1. High level
2. Low Level

M. Differential pressure Gauge

1. 0-10 in.wc. differential pressure gauge to monitor pressure across the biotrickling filter media bed.
2. 316 SS tubing attached to the side wall of the vessel
3. Provide condensate drop-outs

2.2 RECIRCULATION PUMPS

A. Description: Provide based on manufacturer's recommendation and proposed system.

1. Number of Pumps: One duty, one shelf spare.
2. Operation: Pump low pH liquid from the vessel's sump to the spray header.
3. Type: Seal-less, magnetically driven (rare earth, high performance magnets), horizontal, single-stage, base-mounted, end suction centrifugal configuration.
 - a. Manufactured in accordance with ANSI Horizontal End Suction Pumps for Chemical Process.

- b. Five-year warrantee
- c. ISO 1940 G2.5 balancing

B. Performance:

- 1. Capacity: Adequate to meet necessary irrigation pressure and flow requirements. Capacity may be revised as necessary to provide a fully functional system.
- 2. Maximum Horsepower: 5 hp.
- 3. Motor: Horizontal, TEFC, rated for severe duty, squirrel cage induction type, 460V/3/60Hz with Class F insulation and a minimum 1.15 service factor, suitable for continuous and intermittent constant speed operation.
 - a. Pump motor to be non-overloading and not exceed its rated horsepower for the entire curve range.
- 4. Classification: Class 1, Division 2, Group D environment.

C. Materials: Certified by manufacturer to handle low pH liquid and to withstand outdoor elements.

- 1. Pump and Outer Shell: Designed to sit outside without degradation and be exposed to sunlight, corrosive atmosphere, and hot ambient temperatures as specified.
 - a. Electrically non-conductive containment shell resistant to corrosion from low pH process liquid.
- 2. Suction and Discharge: Class 150 standard ANSI flanges.
- 3. Pump Casings: Polypropylene, suitable for pressures at least 1.5 times the shutoff head.
- 4. Impellers: Polypropylene fully open with contoured passages and balanced for high efficiency.
- 5. Shafts: Type 316 stainless steel designed for minimal deflection.
 - a. Shafts are directly exposed to liquid being pumped. Protect shaft with polypropylene shaft sleeves.
 - b. Guide shafts by low PV stationary bearings and rotary sleeve/thrust bearings resistant to corrosion from the process fluid.
- 6. Bearing Frames and Bearing Housing Adapters: Cast iron with chemically resistant two-part epoxy resin coating, with registered fit within pump casing.
- 7. Baseplates: Fiberglass. Support pumps, motors, and have holes for mounting to a concrete equipment pad.
 - a. Pumps and motors to be assembled on baseplates in manufacturer's shop.
- 8. Pump Nameplate: Brass or stainless steel, providing name of manufacturer, model number, rated capacity, head, speed, and any other pertinent data.
- 9. Motor Nameplate: Brass or stainless steel, providing name of manufacturer, serial number, model number, horsepower, speed, voltage, amperes, and any other pertinent data.
- 10. The pump shall be piped with unions on the pump inlet and outlet to facilitate pump removal and replacement.

D. Acceptable Vendors:

1. Vanton Pump and Equipment Corp.
2. ANSI Mag.
3. Finish Thompson
4. Approved Equal.

2.3 DUCTWORK AND DAMPERS

- A. All ductwork, dampers, and appurtenances are specified in Section 233116, "Fiberglass Ductwork and Accessories."
- B. Contractor to furnish ductwork, dampers and accessories. Coordinate required sizes of reducers and fittings with bioscrubber system supplier.

2.4 OPERATION

- A. Nutrient Feed and Recirculation Pump Control Panel: NEMA Type 4X.
 1. Number of Water/Nutrient Control Panel: One water panel.
 2. Located outdoors near the bioscrubber system in a HDPE enclosure that acts as a support and sunshield as specified and shown on the Drawings.
 3. Material: Type 316 stainless steel.
 4. Classification: Unclassified
 5. Components: All necessary instruments, and wiring for proper operation of the system, including:
 - a. Irrigation timers
 - b. Recycle pump starter
 - c. Nutrient Pump: Hand/Off/Timer.
 - 1) Individual Red running light.
 - 2) Amber fault light.
 - d. Recirculation Pump: On/Off.
 - 1) Individual Red running light.
 - 2) Recirculation pump run timer.
 - e. Sump level HIGH Amber Alarm
 - f. Sump level LOW Amber Alarm
 6. Coordinate installation of electrical wiring between control panel and water panel.
 7. Provide the connection of water supply to the water panel
- B. Blower Control Panel:
 1. Fan main power feed terminal
 2. Located outdoors near the bioscrubber system in a HDPE enclosure that acts as a support and sunshield as specified and shown on the Drawings.

3. Contain, main circuit fuses and VFD for manual and automatic starting, stopping, and sequencing of the bioscrubber fan including, but not necessarily limited to, the following (Refer to P&ID):
 - a. Main ON/OFF Switch
 - 1) Individual red running lights
 - 2) Amber fault light
 - b. Irrigation timer.
 - c. Control transformer.
 - 1) May be located outside of the Blower Control Panel within a NEMA 4X 316 SS enclosure.
4. Material: Type 316 stainless steel
5. NEMA Type 4X UL certified.
6. PLC: Reference Division 26.
7. Manufacturer to supply necessary ventilation and cooling to maintain interior temperature between 40 and 80 degrees F under all conditions. Measures to include: Air conditioning, Sun Shields and Ventilators.
8. Necessary power conditioning and DC power supplies to be furnished inside each LCP for proper equipment operation.
9. LCP to include intrinsically safe barriers for termination of any signals to/from hazardous Class 1, Div. 1 and Class 1, Div. 2 areas.
 - a. Provide 2 inch separation or barriers between conductors of intrinsically safe circuits and non-intrinsically safe circuits meeting the requirements of NEC 504.30.A.2.
10. Related Requirements: Control Panels to meet requirements of Division 26. Motor starters to meet the requirements of Division 26.
11. Door: Padlock attachment.
12. Single-Point Power Connection and Grounding Lug: 480V/3/60Hz. Blower and Recirculation Pump Control Panel to contain all power transformers.
 - a. Blower and Recirculation Pump Control Panel to be provided with a surge protection unit on the load side of 120 V control power transformer.
 - b. Control Power Transformer: To have both primary and secondary overcurrent protection and to be sized by the bioscrubber supplier.
13. Provide other appurtenances required for a complete and fully operational control panel.
14. Contractor to provide signal interface wiring between the Blower and Recirculation Pump Control Panel and SCADA as shown on the P&ID, including:
 - a. Fan Status
 - b. Pump Status
15. Electrical Spare Parts:
 - a. Timers and Sockets: one of each type installed.
 - b. Relays and Sockets: one of each type installed.
 - c. Fuses and Circuit Breakers: 1 of each type installed

- d. Light Bulbs: one of each type installed
16. General Lightning Protection: Provided to protect the electronic instrumentation systems from induced surges propagating along the signal and power supply lines.
- a. The protective level is not to interfere with normal operation but be lower than the instrument surge withstand level and be maintenance free and self-restoring.
 - b. House instruments installed in exposed locations (outdoors) in properly grounded, suitable metallic cases.
 - c. Connect ground wires for surge protectors to a good earth ground.
 - d. Where practical, run each ground wire individually and insulated from each other. Protection for all 120 VAC instrument power supply lines.
 - e. Cabinets, Panels and Groups of Field Instruments: Protect by surge suppressors.
 - f. Units to be equal to Transtector No. ACP-100W, AC surge suppressor.
 - g. Individual Field Instruments: Protected by General Electric, Model 9115CCB007; Approved Lightning Protection Company; Zeus, Catalog No. SA-20; Joslyn, Series 1200 or equal.

C. Irrigation Control Panel

- 1. Mounted in a single NEMA 4X panel provided by the manufacturer.
- 2. Located outdoors near the bioscrubber system in a HDPE enclosure that acts as a support and sunshield as specified and shown on the Drawings.
- 3. Includes, but not necessarily limited to, the following (refer to P&ID):
 - a. Pressure Reducing valve
 - b. Water flow control valve
 - c. Water pressure gauge
 - d. Water flow rotometer
 - e. Motor actuated irrigation valve.
 - f. Nutrient Feed diaphragm pump
 - g. Nutrient injection point
- 4. Flow Meter: Flow rate/Totalizer to be measured by a paddlewheel turbine.
 - a. Function/Performance:
 - 1) Operating Temperature: Process liquid temperatures of 40 to 80 degrees F or greater dependent upon liner and an ambient of 40 to 120 degrees F.
 - 2) Pressure Rating: Equal to piping system where meter is installed.
 - 3) Meter must be capable of running empty indefinitely without damage to any component.
 - b. Physical:
 - 1) Material: Polypropylene or Polyvinylidene Fluoride (PVDF).
 - 2) Rotor Pin: PVDF or Hastelloy-C.
 - 3) Power Requirements: Meter to be self-powered.
 - c. Accessories and Documentation Required:

- 1) Factory calibration: Meters to be factory calibrated. A copy of calibration report to be included in the O&M manual.
- 2) For meters with remote mounted transmitters, signal cable for installation between the flow tube and the transmitter. Length will be as required by installation as indicated on the Drawings.
- d. Model: 5500 Signet Rotor-X Paddlewheel or Engineer approved equivalent.
5. High/Low Level Switch:
6. Pressure Gauges: Bourdon tube actuated dial face
 - a. Accuracy: 1 percent or better.
 - b. Casing: Phenolic shock resistant or Type 316 stainless steel.
 - c. Manufacturer by Ashcroft or Engineer approved equivalent.
 - d. The range for normal conditions to be no less than 25 percent of scale.
7. Instruments installed within the classified envelope to be rated for use in Class I Division 2 environments, whether specifically mentioned in this Section or not.

2.5 SOURCE QUALITY CONTROL

- A. **Section 014000**, "Quality Requirements" for testing, inspection, and analysis requirements.
- B. Inspection: Visually inspect scrubber vessel according to ASME RTP-1 Visual Acceptance Level 2.
- C. Testing:
 1. Vessels: Acetone test interior of vessels according to ASTM C582.
 2. Scrubber and Hydrostatic Testing:
 - a. Fill vessel with water to 6 ft. above overflow outlet of each scrubber sump.
 - b. Maintain for 24 hours with no leaks or repair leaks and retest.
 - c. Test control panel and controls.
- D. Certificate of Compliance: If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
 1. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 017300, "Execution" for installation examination requirements.
- B. Verify that facility, piping, and electrical Work are ready to receive scrubber.

- C. Examine pads or supports to receive scrubber, fan, and pumps for proper anchor bolt locations and spacing.

3.2 INSTALLATION

***** [OR] *****

- A. As indicated on Drawings and according to manufacturer's instructions.
- B. Initial Materials: Provide materials, grease, and oil as recommended by equipment manufacturers.
- C. Provide flanged flexible connections at air inlet and at discharge of scrubber exhaust fan.
- D. Provide test ports and air sampling tubes with cocks at each scrubber intake and exhaust stack or duct.
- E. The exhaust duct, power and control wiring, water supply, and drain line will be brought to the concrete pad by The Contractor. The Contractor is responsible for connecting the exhaust duct, power and control wiring, and piping. Contractor will furnish condensate, drainage and water piping as shown on the Drawings.
- F. Provide equipment nameplates as specified in Section 460553 - Identification for Water and Wastewater Equipment.

3.3 FIELD QUALITY CONTROL

- A. Inspection: Verify proper operation of equipment.
- B. Testing, Adjusting, and Balancing:
 - 1. Air balance odor control system as specified in Section 230593, "Testing, Adjusting, and Balancing for HVAC."
 - 2. Check control functions and adjust as required.
 - 3. Testing and Balancing by a certified NEBB company, provided by the Contractor.
- C. Startup: An acclimation period of up to 45 days after initial startup must be allowed for the growth of biological populations.
 - 1. Start-up of the systems is the responsibility of the manufacturer, who will furnish factory-trained personnel to complete this activity. Start-up will commence following a visual inspection and check out of the systems by the manufacturer's technical representative.
- D. Testing:
 - 1. Functional Testing: Prior to system startup, inspect components for proper alignment and connection and acceptable operation.
 - 2. Mechanical Commissioning:
 - a. Irrigation, Recirculation and Nutrient Feed Systems:

- 1) Confirm that all ductwork airflow is balanced.
- 2) Verify proper water level in scrubber and system.
- 3) Verify recirculation pump is operating properly.
- 4) Verify nutrient pump is operating properly.
- 5) Verify operation of differential pressure indicator across scrubber.
- 6) Verify operation of scrubber sump level indicator.
- 7) Log all operating parameters. Continue logging operating parameters for 30 days.

3. Scrubber System Performance Testing:

- a. Performance testing will not commence until the Testing and Balancing Report for the entire ductwork system is submitted and approved by the Engineer, and the approval of a Sampling and Analyses Plan submitted during the mechanical commissioning.
 - 1) Sample collection equipment and hydrogen sulfide monitoring instruments will be freshly calibrated with certification from the manufacturer; the equipment shall be provided by the Manufacturer.
- b. Owner will schedule acceptance testing within 60 days of system startup.
- c. Demonstrate hydrogen sulfide and odor levels in scrubber outlet are in accordance with the performance criteria specified in this section and that pressure drop through scrubber is less than specified in this Section.
- d. Procedure:
 - 1) Operate scrubber system in auto mode.
 - 2) Maintain design operating conditions for minimum six hours after an initial two-hour stabilization period.
 - 3) Monitor and record relevant operating parameters and operating conditions pursuant to the sampling plan.
 - 4) Collect minimum three samples per vessel for odor panel testing, at every two hours.
 - a) Send samples to by overnight delivery for odor analyses at a qualified laboratory.
 - b) Odor concentrations will be measured and analyzed per EN 13725.
 - 5) Continuously monitor hydrogen sulfide levels using a low range sampling system (LRSS from Detection Instruments) that measures H₂S at the inlet and outlet of the scrubber concurrently, Inlet at 1 minute increments and outlet at ten minute increments.
 - 6) Document water use rates and airflow rate
 - 7) If performance criteria are not attained, make adjustments or repairs and repeat test at no additional expense to the Owner.

E. Manufacturer Services:

1. Furnish services of manufacturer's representative experienced in installation of products furnished per this Section.

2. Services Provided by Manufacturer's Representative: Representative will be present at frequent enough intervals to ensure proper installation, testing and initial operation of equipment. Minimum time listed is for each odor control system.
 - a. Supervise Installation: Minimum Number of Trips: 1.
 - 1) Minimum Time on Site: 2 (8 hour working) days.
 - b. Inspect and Approve Installation: Minimum Number of Trips: 1.
 - 1) Minimum Time on Site: 2 (8 hour working) days.
 - 2) Provide to Engineer written certification the system is installed in accordance with manufacturer's recommendation.
 - 3) May be done directly following completion of supervising installation if acceptable to the Engineer.
 - c. Supervise Testing: Minimum Number of Trips: 1.
 - 1) Minimum Time on Site: 1 (8 hour working) day.
 - 2) May be done directly following completion of inspecting and approving installation if acceptable to the Engineer.
 - d. Train Owner's and Engineer's Representatives: Minimum Number of Trips: 1.
 - 1) Minimum Time on Site: 1 (8 hour working) day.
 - 2) May be done following completion of testing supervision if test is successful and operation and maintenance manuals have been approved.
- F. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
 1. Make final adjustments to equipment under direction of manufacturer's representative.
- G. The manufacturer's representative witnessing field tests will furnish the Owner, through the Contractor, a written report certifying that the odor control system:
 1. Has not been damaged by transportation or installation.
 2. Has been properly installed and accurately aligned.
 3. Has no mechanical defects.
 4. Is free from any undue stress imposed by connecting piping and/or anchor bolts.
 5. Is free of overheating of any parts.
 6. Is free of objectionable vibration and noise.
 7. The Contractor has accurately recorded the data obtained during the field test.
 8. Warranty.
- H. Certificate of Acceptance to System Supplier: Issued by Owner upon successful demonstration of operation and head loss.
 1. Warranty period will commence on this date.
 2. System supplier will promptly repair and/or replace defective equipment at no additional cost to the Owner for a period of two years from Date of Certificate of Acceptance.

I. Warranty:

1. Mechanical Components: Two years from Owner acceptance.
2. Vessel, Media Supports, and Media: Ten years from Owner acceptance.

3.4 DEMONSTRATION

A. Section 017900, "Demonstration and Training" for demonstration and training requirements.

- B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 443133

