City of Atlanta
Department of Aviation
Hartsfield-Jackson Atlanta International Airport

TECHNICAL SPECIFICATIONS
VOLUME 2 OF 2
ISSUED FOR BID

SOUTH DEICING
COMPLEX RAMP
IFB-C-1200348
February 10, 2020

ATLNEXT
"The Next Era for Hartsfield-Jackson"

Keisha Lance Bottoms, Mayor

City of Atlanta

John Selden, Airport General Manager

Department of Aviation

PREPARED BY:

AAC
ATL AVIATION CONSULTING

HARTSFIELD-JACKSON ATLANTA INTERNATIONAL AIRPORT
SOUTH DEICING COMPLEX RAMP
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SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. This section applies to work in all of Division 26.

1.2 SECTION INCLUDES:

A. Electrical equipment coordination and installation.
B. Common electrical installation requirements.

1.3 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

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

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

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate with Georgia Power for utility connection requirements

PART 2 EXECUTION

2.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1, NFPA 70, IEEE C2 and Georgia Building Code.

B. All electrical equipment, including switchboards, switchgear, transformers, drives and panelboards, shall be stored in such a fashion to avoid moisture accumulation. Storage

conditions and measures shall conform to NEMA and manufacturers requirements for protection of equipment prior to installation and/or energization.

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

D. All electrical work shall be supervised by a journeyman electrician minimum.

E. Phase rotation shall be verified at each 3-phase panel, safety switch, and receptacle upon installation.

F. Treat ends of cut galvanized strut and other cut edges of galvanized material with a zinc based protective coating.

G. Bond neutrals of transformers and other separately derived sources at the transformer or source. Do not bond the neutral at any panelboard, MCC, disconnect, or other non-source location.

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

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

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

2.2 FIRESTOPPING

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

END OF SECTION 260500

SECTION 26 05 19 - 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 SECTION INCLUDES:

A. Building wires and cables rated 600 V and less.
B. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

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

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers listed but not limited to the following:

1. General Cable Corporation.
2. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

1. Solid for No. 10 AWG and smaller: Stranded for No. 8 AWG and larger.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW and SO.

D. Multi-conductor Cable: Comply with NEMA WC 70 for Type SO with ground wire.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers listed but not limited to the following:

1. Hubbell Power Systems, Inc.
2. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. All conductors shall be copper.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW, single conductors in raceway.

B. Feeders: Type THHN/THWN dual rated, single conductors in raceway unless otherwise noted.

C. Branch Circuits: Type THHN /THWN dual rated, single conductors in raceway.

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

E. Class 1 Control Circuits: Type THHN /THWN dual rated, in raceway.

F. Class 2 Control Circuits: Type THHN /THWN dual rated, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

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

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.

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

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

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 and UL 486B.

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

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

3.5 FIRESTOPPING

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

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.

2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning conductors and connections then retest as specified above.

1. All testing results must be approved prior to energizing of circuits, especially all exterior service entry, exterior circuits, and feeders over 30 amps.

END OF SECTION 260519

SECTION 26 05 26 - 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 SECTION INCLUDES:

A. Methods and materials for grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "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.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells ground rings and grounding connections for separately derived systems based on NETA ATS.

a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.1 CONDUCTORS

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

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable Lightning Protection: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductors: As indicated, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bar: Rectangular bars of annealed copper, with insulators, refer to drawings for size.

D. CONNECTORS

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

2. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

a. Pipe Connectors: Clamp type, sized for pipe.

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

E. GROUNDING ELECTRODES

1. Ground Rods: Copper-clad segmental; 10-foot sections 3/4 inch in diameter.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install stranded conductors, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 3/0 AWG minimum.
1. Bury at least 24 inches (600 mm) below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Bar: Install in electrical telephone and communication equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Exothermic 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: Exothermic Welded connectors.
5. Ground rod segments: Exothermic Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod in handhole, close to wall, and set rod depth so 4 inches (100 mm) will extend above gravel fill.

C. Pad-Mounted Transformers: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and non-current-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 (150 mm) from the foundation.

3.3 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. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

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. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

3.4 INSTALLATION

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

B. Common Ground Bonding 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.

C. Ground Rods: Drive rods until tops are 24 inches (50 mm) below final grade or 2 inches below finished floor, unless otherwise indicated. Add segments to ground rods as required to meet ground resistance, 20-foot minimum rod length.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: 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.

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

F. Grounding and Bonding for Piping:

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

G. 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.

   1. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

      a. Install copper conductor not less than No. 3/0 AWG for ground ring and for taps to building steel.
      b. Bury ground ring not less than 24 inches (600 mm) from building foundation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:

   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

      a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or

seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

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

3. Prepare dimensioned drawings locating each 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.

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

1. Power and Lighting Equipment: 5 ohms.
2. Pad-Mounted Equipment: 5 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values with 3 rod segments, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 26 05 29 - 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 SECTION INCLUDES:

A. Hangers and supports for electrical equipment and systems.
B. Construction requirements for concrete bases.

1.3 Related Sections include the following:

A. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.4 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. RMC: Rigid metal conduit.

1.5 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

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

1.6 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

B. Welding certificates.

1.7 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.8 COORDINATION

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

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

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

1. Manufacturers: Subject to compliance with requirements, available manufacturers listed but not limited to the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

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

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

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

(i) Cooper B-Line, Inc.; a division of Cooper Industries.
(ii) Empire Tool and Manufacturing Co., Inc.
(iii) Hilti Inc.
(iv) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
(v) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.

2.2 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 Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 EXECUTION

3.1 APPLICATION

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

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

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

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

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) 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 and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
4. To Light Steel: Sheet metal screws.
5. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

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

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "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 4 inches 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 Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

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

END OF SECTION 260529

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SECTION 26 05 33 - 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. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. 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.

1.4 ACTION SUBMITTALS

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

B. Sustainable Design Submittals:

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

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 from the following:

a. Allied Tube & Conduit
b. Wheatland Tube Company
c. O/Z Gedney
d. Or approved equal

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. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

a. Comply with NEMA RN 1.
b. Coating Thickness: 0.040 inch (1 mm), minimum.

7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements. Provide products from the following:
   a. Allied Tube & Conduit
   b. Wheatland Tube Company
   c. O/Z Gedney
   d. Or approved equal
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 steel 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 (1 mm), 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. Provide products from the following:
   a. AFC Cable Systems
   b. ARNCO Corporation
   c. Kraloy
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. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.

B. Nonmetallic Fittings:
1. Manufacturers: Subject to compliance with requirements. Provide products from the following:
   a. AFC Cable Systems
   b. ARNCO Corporation
   c. Kraloy
2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for 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.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements. Provide product from the following:
   a. Cooper B-Line Inc.
   b. Hoffman

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 12 with hinge cover 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.

C. 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.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

   1. Manufacturers: Subject to compliance with requirements. Provide products from the following:
      a. Hubbell Incorporated
      b. Wiremold/LeGrand

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements. Provide products from the following:
   a. Hoffman
   b. FSR Inc.
   c. Cooper Crouse-Hinds

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, ferrous alloy aluminum, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal 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. 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.

H. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

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 galvanized, cast iron 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 (100 mm square by 60 mm deep).

M. Gang boxes are allowed.

N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R as indicated with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

O. Cabinets:

1. NEMA 250, Type 12 or Type 4X or as indicated with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.6 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. Provide products from the following:
   a. Armorcast Products
   b. Oldcastle Infrastructure
   c. Jensen Precast
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with 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 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 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

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: IMC

3. Underground Conduit: RNC, Type EPC-40-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250 NEMA 4X.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Pump Room
   b. Mechanical rooms.

2. Concealed in Ceilings and Interior Walls and Partitions: PVC
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
4. Damp or Wet Locations: GRC.
5. Boxes and Enclosures: NEMA 250, Type 12, except use NEMA 250, Type 4X stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) 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. Liquid tight 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 (49 deg C).

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 (150 mm) 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 (300 mm) 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 (300 mm) of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
4. Do not embed thread less fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from RNC to GRC before rising above floor.

M. Stub-Ups to Above Recessed Ceilings:

1. Use, IMC, or 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 (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) 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 (53-mm) 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 (90-kg) tensile strength. Leave at least 12 inches (300 mm) 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 (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) 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 (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC conduit that is located where

environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

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 (70 deg C) temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    d. Attics: 135 deg F (75 deg C) 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 (0.06 mm per meter of length of straight run per deg C) 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 (0.0115 mm per meter of length of straight run per deg C) 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 (1830 mm) 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 top 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.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.5 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

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SECTION 26 05 43 - 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 SECTION INCLUDES:

A. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks.

1.3 DEFINITIONS

A. RNC: Rigid nonmetallic conduit

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Warning tape.

1.5 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.7 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and

elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Engineer.

PART 2 PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers listed but not limited to the following:

1. Cantex, Inc.
2. CertainTeed Corp.; Pipe & Plastics Group.
3. Condux International, Inc.
4. ElecSys, Inc.
5. IPEX Inc.
6. Lamson & Sessions; Carlon Electrical Products.
7. Manhattan/CDT; a division of Cable Design Technologies.
8. Spiraduct/AFC Cable Systems, Inc.

B. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

PART 3 EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Underground Ducts concrete encased as indicated on the drawings.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Building Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to other sections.

3.3 DUCT INSTALLATION

A. 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 (1220 mm), both horizontally and vertically, at other locations, unless otherwise indicated.

B. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

C. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 5 feet (3 m) 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 duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

D. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

E. Pulling Cord: Install 200-lbf- (445-N-) test nylon cord in ducts, including spares.

3.4 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
2. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.6 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes. Remove foreign material.

END OF SECTION 260543

SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS 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 SECTION INCLUDES:

A. Isolation pads.
B. Spring isolators.
C. Restrained spring isolators.
D. Channel support systems.
E. Restraint cables.
F. Hanger rod stiffeners.
G. Anchorage bushings and washers.

1.3 RELATED SECTIONS INCLUDE:

A. Division 26 Section "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.4 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.

    a. Component Importance Factor: 1.25.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): .367.
4. Design Spectral Response Acceleration at 1.0-Second Period: .179.

1.6 SUBMITTALS

A. Product Data: For the following:

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 seismic-restraint component used.
3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

    a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.

C. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

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

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

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

a. Ace Mountings Co., Inc.
b. Amber/Booth Company, Inc.
c. California Dynamics Corporation.
d. Isolation Technology, Inc.
e. Kinetics Noise Control.
f. Mason Industries.
g. Vibration Eliminator Co., Inc.
h. Vibration Isolation.
i. Vibration Mountings & Controls, Inc.

B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

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

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.

B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

C. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.

D. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchors and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

G. Mechanical Anchor: HILTI KWIK BOLT II zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

H. Adhesive Anchor: HILTI HVA System, minimum embedment length 6” inches.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

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 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548

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SECTION 26 05 53 - 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 SECTION INCLUDES:

A. Identification for raceway and metal-clad cable.
B. Identification for conductors and communication and control cable.
C. Underground-line warning tape.
D. Warning labels and signs.
E. Instruction signs.
F. Equipment identification labels.
G. Miscellaneous identification products.

1.3 Related Sections include the following:

A. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.4 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.5 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:

1. Emergency Power Circuits: Black letters on an orange field.
2. Normal Power Circuits: Black on a White field.
3. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.2 CONDUCTOR, COMMUNICATION CABLE AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, red-color, continuous-printed, polyethylene tape.

1. 3 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
3. Comply with Gulfstream Aerospace Corporation Facilities Standard No. 16-001 and 16-003.

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16-inch-thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with white letters on black face and white letters on red face for emergency power.
2. Punched or drilled for mechanical fasteners.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

C. 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 APPLICATION

A. Raceways and Duct Banks More Than 600 V Concealed within Buildings: 4-inch- wide black stripes on 10-inch centers over red background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply 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.

B. Accessible Raceways more than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high on red background with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

C. Conductors of special systems, such as emergency power shall be clearly labeled at all outlets, devices, and boxes to clearly distinguish them from normal building 60 HZ wiring.

D. Accessible Raceways, 600 V or less, for Service and Feeder, Circuits more than 90 A: Identify with white letters on black background with self-adhesive vinyl label.

E. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Combined Fire Alarm and Security System: Red and blue.
4. Security System: Blue and yellow.
5. Mechanical and Electrical Supervisory System: Green and blue.
6. Telecommunication System: Green and yellow.
7. Control Wiring: Green and red.

F. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, and handholes use color-coding conductor tape.

G. Conductors of special systems, such as emergency power, DC, and 400 HZ power, shall be clearly labeled at all outlets, devices, and boxes to clearly distinguish them from normal building 60 HZ wiring. Conductors of special systems shall be run in separate conduit or raceway.

H. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape.

I. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

K. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access. Provide arc flash labeling per NFPA 70E for all equipment enclosures.

1. 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.
   c. Substations.
   d. Switchboards.

2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

M. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
2. Emergency Operating Instructions: 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.

N. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, Operation and Maintenance Manual and Gulfstream Aerospace Corporation Facilities Standard No. 16-001. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high.
b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.
b. Access doors and panels for concealed electrical items.
c. Electrical switchgear and switchboards.
d. Transformers.
e. Electrical substations.
f. Power outlets
g. Light switches
h. Emergency system boxes and enclosures.
i. Motor-control centers.
j. Disconnect switches.
k. Enclosed circuit breakers.
l. Motor starters.
m. Push-button stations.
n. Power transfer equipment.
o. Contactors.
p. Remote-controlled switches, dimmer modules, and control devices.
q. Power-generating units.
r. Voice and data cable terminal equipment.
s. Fire-alarm control panel and annunciators.
t. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
u. Monitoring and control equipment.
v. Uninterruptible power supply equipment.
w. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or, for sizes larger than No. 6 AWG if authorities having jurisdiction permit, field applied.

2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White
e. Ground: Green

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.
d. Neutral: Gray
e. Ground: Green

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line 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.

I. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION 260553

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SECTION 26 05 73 - SHORT CIRCUIT, OVERCURRENT DEVICE COORDINATION-ARC FLASH STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is not permitted.
2. Result shall be an electrical system with fully rated selectively coordinated overcurrent devices.
3. Scope of study shall include all new electrical equipment and installations and all existing installations that are affected by the new.

1.2 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study and fault-current study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed.

1. Coordination-study and fault-current study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study and Fault-Current Study Report.

1.3 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Basis-of-Design Product: Provide computer analysis with SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Additional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence
d. Mutual coupling in zero sequence.

2.3 ARC FLASH LABELING REQUIREMENTS

D. Comply with NFPA 70E and OSHA requirement.

E. Provide labels for all starters, switchgear, switchboards, panelboards, disconnects, equipment electrical panels and drives.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    f. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    g. Panelboards and switchboards, interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Main switchboard distribution busses.
2. Distribution panelboard.
3. Branch circuit panelboard.
4. Engine generator transfer switches.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.
b. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
c. Fuse-current rating and type.
d. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.
b. Voltage and current ratio for curves.
c. Three-phase and single-phase damage points for each transformer.
d. No damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer inrush points.
g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH HAZARD STUDY

A. Provide an Arch Flash Hazard Study for the electrical distribution system shown on the one-line drawings updated to use equipment actually installed, if different. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment shown on the one-line drawing. This includes switchboards, panelboards, motor control centers, UPS, ATS's, and transformers. The study will include creation of Arc Flash Hazard Warning Labels to serve as a guide to assist technicians and others in the selection of proper Personal Protective Equipment when working around exposed and energized conductors. The electrical contractor will install the labels.

B. The Arc Flash Hazard Study shall consider operation during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum arc flash hazard.

C. Perform the Arc Flash Hazard Study after the short circuit and protective device coordination study has been completed based upon IEEE Std 1584, “IEEE Guide For Performing Arc Flash Hazard Calculations”. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards. Determine the following:

1. Flash Hazard Protection Boundary.
2. Limited Approach Boundary.
3. Restricted Boundary.
4. Prohibited Boundary.
5. Incident Energy Level.
6. Required Personal Protective Equipment Class.
7. Type of Fire Rated Clothing.

D. Produce an Arc Flash Warning label listing items 1-7 above. Also include the bus name, system operating voltage, and date of issue. Labels shall be printed in color and be printed on adhesive backed Avery Labels.

E. Produce Bus Detail sheets that list the items C 1-7 from above and the following additional items:

1. Bus Name.
2. Upstream Protective Device Name, Type, and Settings.
3. Bus Line to Line Voltage.

F. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:

1. Bus Name.
2. Upstream Protective Device Name, Type, and Settings.
3. Bus Line to Line Voltage.
4. Bus Bolted Fault.
5. Protective Device Bolted Fault Current.
6. Arcing Fault Current.
7. Protective Device Trip/Delay Time.
8. Breaker Opening Time.
9. Solidly Grounded Column.
10. Equipment Type.
11. Gap.
12. Arc Flash Boundary.
13. Working Distance.
14. Incident Energy.
15. Required Protective Fire Rated Clothing Type and Class.

G. Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels.

3.6 REPORTS

A. The results of the power system study shall be summarized in a final written report. The report shall include the following sections:

1. Executive Summary – A synopsis of our overall findings, including but not limited to equipment locations with highest incident energy levels, total number of overcurrent protective devices with inadequate short circuit current interrupting ratings, and identification of equipment protective boundary conflicts.
2. Introduction – A brief paragraph to explain the necessity of performing an arc flash hazard analysis and the criteria used during the project.
3. Methodology – A brief paragraph to explain the basis for the analyses performed for this project.
4. Assumptions – A list of all valid engineering assumptions made and why they were made during the course of the project.
5. Discussion – A detailed discussion of each of the following power system analysis performed for this project:

    a. Short Circuit Analysis Results.
    b. Protective Device Coordination Study Results.
    c. Arc-Flash Hazard Analysis Results.

6. Recommendations – Our detailed recommendations to reduce existing incident energy levels and to improve overall future maintenance & operation of the plant.
7. Bibliography – Industry references used to complete the arc-flash analysis for this plant.

B. Provide three (3) copies of each report together with one electronic copy of the SKM files for the Engineer.

END OF SECTION 260573

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SECTION 26 09 23 - 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. This Section includes the following lighting control devices:

1. Outdoor photoelectric switches.
2. Lighting contactors.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 LIGHTING CONTROL

A. Controller: Electronic, solid-state programmable units with alphanumeric display

1. Contact inputs for photocell.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

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

1. Intermatic, Inc.
2. Paragon Electric Co.; Invensys Climate Controls.
3. TORK.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.4 LIGHTING CONTACTORS

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

1. Allen-Bradley/Rockwell Automation.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Electrical Inc.; Cutler-Hammer Products.
4. Square D; Schneider Electric.

B. Description: Electrically operated and mechanically held, combination type with, complying with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA 12
2. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure as indicated.

2.5 EXECUTION

3.1 CONTACTOR INSTALLATION

C. 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.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section 260519. Minimum conduit size shall be 3/4 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Per manufacturers requirements for system

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 260923

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SECTION 26 20 00

ELECTRIC MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Low voltage electric motors and accessories, furnished under other Sections, and which are a part of equipment assemblies shall be in conformance with the requirements specified in this Section, unless otherwise noted. This section includes performance, and descriptive type specifications.

B. Unless otherwise specified or approved, all electric motors furnished and installed by the Contractor shall conform to the requirements specified herein.

1. Motors connected to Variable Frequency Drives shall be inverter duty rated in accordance with the requirements of NEMA MG-1.

2. Motors rated 1 hp or greater shall be premium efficient type per NEMA MG-1.

1.02 REFERENCES:

A. Institute of Electrical and Electronics Engineers (IEEE).

1. 112: Test Procedures for Polyphase Induction Motors and Generators.

2. 1349: IEEE Guide for the Application of Electric Motors in Class 1, Division 2 Hazardous (Classified) Locations.

B. National Electric Manufacturer's Association (NEMA):

1. MG-1: Motors and Generators.

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

1.03 SUBMITTALS

A. Shop drawings: Submit the following in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 00.

1. Descriptive literature and motor characteristics.

2. Shop drawings and descriptive data to include:

a. Complete list of all motors to be furnished.

b. Outlines, dimensions, weights, and wiring diagrams.

c. Location of main and accessories boxes with size of conduit entrance.

d. Efficiency and power factor at 1/2, 3/4 and full load.

e. Bearing design data and grease requirements.

f. Nameplate data.

g. Shop test report.

h. Field acceptance test report.

i. Strip heaters KW and voltage ratings.

j. Power factor correction capacitors, where required.

k. Built in overload protection device.

l. Starting restrictions, acceleration time-current curve of motor starting load (100 hp and larger).

m. Thermal damage curve and allowable stall time, full voltage (100 hp and larger).

3. Submit Pump, Motor and VFD Coordination Certificate. Refer to Section 01 33 00 for form.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Section 01 43 00 and as specified.

B. Motors to comply with the latest reference standards listed below.

1. National Electrical Code (NEC).

2. Underwriters Laboratories, Inc. (UL).

3. National Electric Manufacturer's Association (NEMA).

a. NEMA Standard MG-1 - Motors and Generators.

4. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA).

5. American National Standard Institute (ANSI).

6. Institute of Electrical and Electronics Engineers (IEEE).

a. IEEE Standard 112 - Test Procedures for Polyphase Induction Motors and Generators.

b. IEEE 1349 - IEEE Guide for the Application of Electric Motors in Class 1, Division 2 Hazardous (Classified) Locations.

C. Routine tests shall be performed on representative motors, and shall include the information described on NEMA MG1-12.54 Report of Test Form for Routine Tests on Induction Motors. Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Section 01 66 10 and as specified.

B. Shipping:

1. Ship motors assembled to driven equipment complete except where partial disassembly is required by transportation regulations or for protection of components.

2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

3. Deliver spare parts at same time as pertaining materials. Delivery to Owner after completion of work.

C. Receiving and Storage:

1. Inspect and inventory items upon delivery to site.

2. Store and safeguard equipment and material in heated storage facility as recommended by equipment manufacturer and required by Section 01 66 10.

3. Protect motors from moisture at all times.

D. Prolonged Storage:

1. For extended outdoor storage, remove motors from equipment and store separately.

2. If storage is anticipated to be longer than two months, store in accordance with the manufacturer instructions including the following additional steps.

3. Maintain motor space heaters energized.

4. Fill the oil reservoirs of motors with sleeve bearings to the proper level with the specified oil.

5. Motors with anti-friction bearings to receive an initial change of grease and then be re-greased every six months.

6. Remove the motor shaft braces and the rotate motor shaft every two weeks. Replace the shaft braces prior to relocation to the installation site. Under no circumstances should the motor be lifted without the braces in place.

PART 2 - PRODUCTS

2.01 MOTOR MANUFACTURERS:

A. General Electric Company.

B. Reliance Electric.

C. U.S. Motors.

2.02 ELECTRIC MOTOR RATINGS:

A. Voltage Ratings:

1. Unless otherwise specified, motors with ratings of 1/2 up to and including 200 hp (0.37 to 150 kW) shall be rated 460-volt (nameplate rating), three-phase, 60-Hertz; motors of 1/3 hp (0.25 kW) or less to be rated 115-volt, single-phase, 60 Hertz.

2. High voltage motors, if indicated on drawings, shall be specified elsewhere in the specifications.

B. The following specific motor requirements shall be in the equipment specifications:

1. RPM.

2. Motor enclosure type.

2.03 MOTOR DESIGN REQUIREMENTS:

A. Motor heaters shall be supplied on all motors installed outdoors or in unheated areas. Heaters shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 volt, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate.

B. Unless otherwise specified or permitted all electric motors furnished and installed by the Contractor shall conform to the requirements hereinafter set forth.

C. Motors connected to variable frequency drives shall be inverter duty rated.

D. Every motor shall be of sufficient capacity to operate the driven equipment under all load and operating conditions without exceeding its rated nameplate current or power or its specified temperature limit at rated voltage. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where indicated on the electrical drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.

E. The motor shall have sufficient capacity to operate the driven equipment as given in the equipment detail specifications. The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.

F. The motor shall be suitable for rated horsepower and full service factor operation at elevation above sea level corresponding to the site of installation of the motor.

G. Type of Motors:

1. All motors shall be NEMA Design B or of a type having starting characteristics and ruggedness as may be necessary under the actual conditions of operation and, unless otherwise specified, shall be suitable for full-voltage starting.

H. Insulation:

1. All motors shall have Class B or Class F insulation with temperature rise by resistance at full load rating of a Class B insulation in accordance with NEMA Standards for Motors and Generators, NEMA MG1, and based on a maximum ambient temperature of 40 degrees C unless otherwise specified.

2. Insulation systems shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies and mechanical or thermal shock for 480 volt motors. Provide 80 degrees C, Class B rise or better by resistance at 100 percent load and provide a Class F insulation system, suitable for an ambient temperature motor operation of 0 to 40 degrees C at no more than 3,300 feet above sea level for inverter duty motors. This temperature rise shall be met when motors are operated and controlled with the VFD(s). The motor insulation system shall have full capability to handle the common mode voltage conditions imposed by the VFD.

3. Motors for outdoor service shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.

4. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. Class H varnish shall be used.

I. Enclosures:

1. Motors shall have a steel or cast iron frame and a cast iron or stamped steel conduit box, as specified below. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material. A frame mounted pad with drilled and tapped hole, not less than 1/4-inch diameter, shall be provided inside the conduit box for motor frame grounding.

a. Totally enclosed fan cooled: TEFC motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 40 degrees C, tapped drain holes (corrosion resistant plugs for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger) and upgraded insulation by additional dips and bakes to increase moisture resistance.

b. Totally enclosed non-ventilated: TENV motors shall include the same rating and accessories as specified for TEFC motors.

c. Explosion proof motors shall comply with all requirements of Class I, Division I, Group D, hazardous locations as defined by the NEC and with all other safety codes pertaining thereto.

J. Special Purpose Motors:

1. Chemical duty motors shall be provided with severe duty rating. Motors shall be of the corrosion resistant type conforming to motors designated by the manufacturer as Corro-Duty, Mill and Chemical, Custom Severe Duty, or similar quality designation. Severe duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box and 1.15 service factor at 40 degrees C and tapped drain holes (corrosion resistant plug for frames 286T and smaller and automatic breather/drain devices for frames 324T and larger).

2. Hermetically sealed air conditioning units, elevators, hoists, cranes and other devices complying with special safety codes shall be furnished with motors, control equipment, accessories and safety devices for approved, safe, and efficient operation, in accordance with the manufacturer's standards and to be rated for the duty cycle as specified for the driven equipment. Minimum service factor 1.15 above 3 hp.

3. Submersible motors shall be manufacturer's standard.

4. Synchronous and wound rotor motors shall be specified elsewhere in the specifications when required.

5. Inverter duty rated: Motors for operation on variable frequency drives shall meet current power quality levels published in NEMA MG1, Part 31. Enclosures shall be equal to those furnished for severe duty or explosion proof motors. Motor shaft and bearings shall be insulated. Internal service factor shall be 1.15 that of the nameplate. Ventilation system shall be designed for maximum heat transfer. Stator laminations shall be stagger-stacked and stamped from high grade electrical steel to minimize eddy-current losses and heat build-up caused by inverter induced harmonics. Rotors shall be configured to minimize skin-effect heating.

K. Auxiliary Devices:

1. Three phase motors shall not be provided with starting capacitors.

2. Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in suitable enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and to be provided with a single conduit box.

3. Motors 200 hp or over, or where specified in other sections, shall have built-in overload protection device. Winding temperature detectors, shall be factory installed, embedded, bi-metallic switch type or thermistors with relay with leads terminating in the main conduit box. This device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure. The switch shall have normally closed contacts. Not less than three detectors shall be furnished with each motor.

L. General Design of Motors:

1. Motors shall comply with the latest NEMA Standards Publication No. MG1 for Motors and Generators, unless otherwise specified.

2. All polyphase non-explosion proof motors shall be designed for energy efficient operation and meet the requirements of MG1-12.53 a and b.

3. Motor windings shall be braced to withstand successfully the stresses resulting from the method of starting. The windings shall be treated thoroughly with acceptable insulating compound suitable for protection against moisture and slightly acid or alkaline conditions.

4. Bearings shall be of the self-lubricating type, designed to ensure proper alignment of rotor and shaft and to prevent leakage of lubricant.

    a. Bearings for open motors shall be of the sleeve or ball type, as specified under the respective items of mechanical equipment.

    b. Bearings for totally enclosed and explosionproof motors shall be of the ball type.

    c. Bearing minimum L-10 fatigue life in hours at 100 percent load shall be 50,000.

    d. Bearing grease shall be of the 120 degrees C thermal capability type.

5. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.

6. Vertical motors of the open type shall be provided with drip hoods of acceptable shape and construction. When the drip hood is too heavy to be easily removed, provision to be made for access for testing.

7. All three phase two speed motors shall be of the two-winding design.

8. All three phase motors shall be provided with a 1.15 service factor.

9. Three phase motors shall be of cast iron construction including frame and end brackets.

10. Totally enclosed motors shall be provided with automatic breather and drain

11. Motor nameplates shall be stainless steel.

12. Motor Terminal Boxes and Leads:

    a. Motors shall be furnished with oversize conduit terminal boxes to provide for making and housing the connections, and with flexible leads of sufficient length to extend for a distance of not less than 4 inches beyond the face of the box. The size of cable terminals, and terminal box conduit hoses shall be as permitted by the Engineer. An acceptable type of solderless lug to be furnished. Totally enclosed and explosionproof motors to have cast-iron terminal boxes.

    b. Leads for space heaters shall be brought out into an auxiliary, cast, conduit box on the motor side opposite to the main terminal box. Auxiliary box to have 1 inch (50 mm) threaded conduit openings and shall be so constructed that conduit entrance may be placed at top, bottom, or either side.

    c. A grounding terminal shall be provided in the main terminal box and a bronze grounding bolt to be furnished at the conduit side of the motor frame.

M. Motor Efficiencies:

1. Three phase motors rated 1 hp and larger shall be of the premium efficiency, “Design E”, type per Table 12.1 of NEMA MG1 Part 12. Motors shall have a NEMA Nominal Efficiency not less than the values referenced in NEMA MG1. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112, Method B. Motors with horsepower or rpm’s not listed shall conform to comparable standards of construction and materials as those for listed motors.

N. Shop Painting:

1. Unless otherwise specified, motors shall be given a shop application of paint filler or enamel sealer, a flat coat of undercoater for enamel, and two coats of enamel or, in lieu of this treatment, other corrosion-resistant treatment customary with the manufacturer.

O. Motor Data:

1. The Contractor shall furnish the Engineer with five certified copies of characteristic curves of each motor furnished, except 115-volt motors. Curves shall be supplied as a part of the driven equipment submittal.

P. Motor Shop Tests:

1. Motor shop tests shall be made in accordance with the IEEE Test Codes as specified in the NEMA MG1 Standards for Motors and Generators. NEMA report-of-test forms to be used in submitting test data.

2. Motor efficiency shall be determined by use of IEEE Standard 112 Test Method B, and by use of MGI-12.53 a and b.

3. For induction motors larger than 100 hp, complete tests of each motor furnished to be made and certified tests data sheets to be submitted, unless witness shop tests are required by the technical specifications pertaining to the equipment. Each motor shall be tested at rated voltage for: efficiency and power factor at 50, 75, and 100 percent of it rated horsepower; for temperature rise, torque, no-load current, starting current, full load current, and dielectric strength; and for compliance with all specified performance requirements.

4. For induction motors 5 hp, up to and including 100 hp, copies of routine tests reports of electrically duplicate motors shall be furnished.

5. For motors 3 hp or less, no test data need be furnished.

Q. Spare Parts:

1. Provide in accordance with Section 01 78 23 and as specified.

2. Furnish one spare bearing of each type for each motor size and type.

R. Capacitors for Motors:

1. All three phase, non-explosionproof 460 volt motor (except for motors driven through variable frequency drive units) shall be provided with a capacitor of the maximum kVAR.

Size recommended by the motor manufacturer and in accordance with the requirements of the NEC.

2. Capacitors shall be furnished with the motors. All capacitors to be installed and wired in accordance with the requirements of the NEC.

3. Capacitor shall be rated 600 volt, 3-phase, 60 Hertz.

4. Each capacitor unit to be enclosed in a corrosion-resistant weatherproof dusttight housing for indoor/outdoor use with threaded conduit connection. A heavy duty corrosion-resistant wall rack shall be provided with each capacitor. Discharge resistors to be included to reduce the voltage to 50 volts or less within one minute after the capacitor is disconnected from the source.

5. Capacitors shall be dry film or liquid insulated and shall be hermetically sealed in steel enclosures.

6. Each capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuss shall be equipped with blown-fuse indicators.

7. Capacitor enclosures shall be suitable for conduit connection and of the NEMA enclosure type required for the area as indicated on the Drawings. Covers shall be gasketed, bolt-on type.

8. Capacitors shall be UL listed.

9. Capacitors shall be by General Electric Co.; Square D Co.; Sprague; or equal.

2.04 ELECTRICAL INTERFACE:

A. All items of electrical equipment that are furnished with process, heating, ventilating, or other equipment shall conform to the requirements specified under the applicable electrical sections of the Division 26 specifications. Enclosures for electrical equipment such as switches, starters, etc., shall also conform to the requirements specified under the applicable electrical sections of the Division 26 specifications.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Verify heaters are energized on motors installed in outdoor or unheated areas.

B. After motor installation but before connection to power wiring, test motor winding insulation in accordance with the applicable Division 26 requirements.

C. After connection to power wiring, check for operating temperature, correct rotation, vibration, alignment and operating current drawn under load.

D. Submit all motor test results for review and record.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 26 20 00

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. 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. 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. Source quality-control test reports.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: approved equal product by one of the following:
1. Eaton Electrical Inc.
2. General Electric Company.
3. Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

F. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

G. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. 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.

K. Wall Brackets: Manufacturer's standard brackets.

L. Fungus Proofing: Permanent fungicidal treatment for coil and core.

M. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
   1. 9 kVA and Less
   2. 30 to 50 kVA
   3. 51 to 150 kVA
   4. 151 to 300 kVA
   5. 301 to 500 kVA
   6. 501 to 750 kVA
   7. 751 to 1000 kVA

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

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 Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Bond neutrals of transformers at the transformer. Do not bond the neutral at any panelboard, MCC, disconnect, or other non-source location.

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

G. Wire termination at dry transformers shall be with crimped lugs if practical. If used, mechanical lugs shall not reduce the clearance to the grounded enclosure.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.3 CONNECTIONS

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

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

3.4 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 components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. 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 2 follow-up infrared scans of transformers, one at 4 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.

E. 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 10 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 262200

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SECTION 26 24 13 - DISTRIBUTION SWITCHBOARD – AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.1 SCOPE

A. Service Entrance Rated Automatic Transfer Switch - Low Voltage, Distribution Switchboard with mold case circuit breakers as specified hear in and as indicated on the drawings.

1.2 REFERENCES

A. The Service entrance transfer switch shall be UL 891 listed and labeled and UL 1008 listed

B. The low voltage switchboards and protection devices in this specification are designed and manufactured according to latest revision of the following standards (unless otherwise noted).

1. ANSI 61
2. ANSI/NEMA PB 2, Deadfront Distribution Switchboards
3. ANSI/NEMA PB 2.1, General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
4. ANSI/NFPA 70, National Electrical Code.
5. NEMA AB 1, Molded Case Circuit Breakers and Molded Case Switches.
6. UL 489, Molded Case Circuit Breakers.
7. UL 891, Dead Front Switchboards.
8. UL 98, Enclosed and Dead Front Switches.
9. UL 1066, Low Voltage Power Circuit Breakers.

1.3 DEFINITIONS

A. Front-Connected only shall be as defined by UL 891 standard which requires that all line and load connections for phase, neutral, and ground conductors can be made and maintained from the front of the switchboard without access to the rear.

B. Front-Accessible shall be as defined by UL 891 standard which is an enclosure in which all bus and device connections are accessible from the front. If necessary, a limited number of devices shall be permitted to be removed to achieve this accessibility.

1.4 SYSTEM DESCRIPTION

A. The Transfer Switch and Distribution Switchboard shall be a factory assembled integral unit and be suitable for 480Y/277 volts, 60 Hertz, 3 phase, 4-wire, solidly grounded wye.

B. The Assembly arrangement shall have front connected and rear aligned.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transfer Switch and Distribution Switchboard 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. High seismic loading as defined in IEEE Std 693-1997, with 1.33 amplification factor.
3. IBC-2006, Sds = 1.05g, Ss = 158%, Ip = 1.5, for all z/h greater than 0 and Sds = 1.67g, Ss = 250%, Ip = 1.5, for z/h equal to 0 in accordance with ICC-ES-AC156.

1.6 SUBMITTALS

A. Provide factory prepared drawings and evaluation in accordance with general requirements of Division 01.

1. Shop Drawings shall include, Front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral and ground; switchboard instrument details; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings and equipment short circuit ratings.

1.7 INSTALLATION, OPERATION AND MAINTENANCE DATA

A. Manufacturer shall provide installation, operation and maintenance procedures to owner in accordance with general requirements.

1.8 DELIVERY, STORAGE AND HANDLING

A. Store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.

B. Ship each section in individual shipping splits for ease of handling. Each section shall be mounted on shipping skids and wrapped for protection.

C. Contractor shall inspect and report concealed damage to carrier within 48 hours.

D. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

E. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish. Lift only by manufacturers recommended procedures.

1.9 PRODUCT CONDITIONS SITE ENVIRONMENTAL CONDITIONS

A. Follow (standards) service conditions before, during and after switchboard installation.

B. Low voltage switchboards shall be located in well - ventilated areas, free from excess humidity, dust and dirt and away from hazardous materials. Ambient temperature of area will be between minus 30 and plus 40 degrees C. Indoor locations shall be protected to prevent moisture from entering enclosure.

1.10 WARRANTY

A. Manufacturer warrants equipment to be free from defects in materials and workmanship for 1 year from date of installation or 18 months from date of purchase, whichever occurs first.

1.11 FIELD MEASUREMENTS

A. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB

B. Square D.

C. Eaton Electrical.

D. Siemens.

2.2 SERVICE ENTRANCE AUTOMATIC TRANSFER ASSEMBLY

A. Transfer switch: System consists of a double throw, electrically operated switch to automatically transfer and re-transfer load to and from a standby power source. The switch assemble shall be controlled by a microprocessor controller.

B. When voltage on any phase drops below 85 percent of normal for a time period of three seconds, a set of engine starting contacts close. Transfer occurs when voltage and frequency on the emergency source have reached 95 percent of normal.

C. Re-transfer to normal occurs when the normal source has reached 95 percent of normal voltage for a period of 20 minutes. However, should the emergency source fail during the 20 minute timing period, re-transfer shall occur immediately.

D. After re-transfer the engine start contacts shall remain closed for a five minute cool down period.

E. The transfer switch assembly controls shall include:

1. Programmable test switch.
2. Built-in diagnostics with LCD.

3. Event Log tracking at least 99 events.
4. Fully programmable time delay functions. To include delay start, delay retransfer, delay cool down.
5. Programmable exerciser clock.
6. Four NO & NC auxiliary contacts.
7. Three phase voltage imbalance monitor.

F. Main Circuit Breaker: Molded Case Circuit Breakers: NEMA AB-1; FS W-C-375; provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

G. Surge Protection: Provide transient voltage surge suppressor, UL listed in accordance with UL 1449 (2nd Edition); suitable for high exposure level ANSI/IEEE C62.41 Cat. C3 environments; total surge current shall not be less than 240 kA per phase or 120 kA per mode in accordance with NEMA LS-1. Provide surge suppressor with standard overcurrent protection, integral disconnect and diagnostic indicating lights. Suppressor shall be installed in the switchboard on the load side of the main disconnect device, as close as possible to the phase/neutral/ground conductors per manufacturer's recommendations.

H. Instruments and Sensors

1. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
2. Potential Transformers: ANSI C57.13; 120 volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
3. Circuit Monitor: Microprocessor based unit for measuring multiphase variables including amps, volts, VARS, watts, volt-amps, power factor, frequency, demand values and harmonic distortion indication. Communications: ModBus RTU protocol; digital and analog inputs and outputs; RS232 port on front; RS485 ports on rear.

2.3 SWITCHBOARD CONSTRUCTION

A. Switchboard: NEMA 1A factory-assembled; dead front; metal-enclosed; front accessible; self-supporting switchboard assembly conforming to NEMA PB-2; complete from incoming line terminals to load-side terminations.

B. Switchboard Electrical Ratings and Configurations as indicated.

C. Distribution Section Devices: Panel mounted.

D. Bus: Copper sized in accordance with NEMA PB-2. Provide a copper ground bus through the length of the switchboard.

E. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

F. Molded Case Circuit Breakers: NEMA AB-1; FS W-C-375; provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install automatic transfer switch and switchboard assembly in locations shown on Drawings, in accordance with manufacturer's written instructions and NEMA PB-2.1.

B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

3.2 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage and grounding.

B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1,000 volts, and minimum acceptable value for insulation resistance is 2 megohms.

C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.

D. Touch up scratched or marred surfaces to match original finish verify field measurements are as shown on Drawings.

E. Verify that required utilities are available, in proper location and ready for use.

3.3 TEST REPORTS

A. Adjust voltage and transfer time settings to the values listed above in Article1.03.

B. Functionally test the completed installation by tripping the utility source main breaker. The Engineer reserves the right to witness this test and 10 day’s notice shall be provided.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

D. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
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, demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify pickup and dropout voltages by data readout or inspection of control settings.
   d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
   f. 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.
   g. Verify grounding connections and locations and ratings of sensors.

E. Testing Agency's Tests and Inspections:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. 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.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 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.

h. Verify grounding connections and locations and ratings of sensors.

F. Coordinate tests with tests of generator and run them concurrently.

G. 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.

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

I. 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. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 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 switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262413

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SECTION 26 24 16 - 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 SECTION INCLUDES:

A. Distribution panelboards.
B. Lighting and appliance branch-circuit panelboards.

1.3 Related Sections include the following:

A. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.4 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. SPD: Surge protective device.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 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."

1.6 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types and details for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Short-circuit current rating of panelboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

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.

E. 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.

F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. 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.

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. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.8 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.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg F 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.

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and

adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

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

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

1.12 EXTRA MATERIALS

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

1. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged to front cover (Door-in-Door): Entire front trim hinged to box.
4. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric NQOD, NF or I-Line or approved equal product by one of the following:

1. Eaton Electrical Inc.
2. General Electric Company.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes larger than 125 A: Bolt-on circuit breakers; bolt-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D NQOD, NF, or I-Line or approved equal product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D or approved equal product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. ABB
3. Siemens Energy & Automation, Inc.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: 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.

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

PART 3 EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1, NFPA 70 and Georgia Building Code.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Mount top of trim 90 inches above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

I. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section 260553.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section 260553.

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. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
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:

(i) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 262416

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SECTION 26 27 26 - 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 SECTION INCLUDES:

A. Receptacles, receptacles with integral GFCI, and associated device plates.

B. Twist-locking receptacles.

C. Isolated-ground receptacles.

D. Snap switches.

E. Pendant cord-connector devices.

F. Cord and plug sets.

G. Floor service outlets, poke-through assemblies, service poles, and multi-outlet assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. SPD: Surge Protective Device.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All devices shall be UL listed as compatible with stranded wire.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

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

a. Hubbell; CR 5253IG.

b. Leviton; 5362-IG.
c. Pass & Seymour; IG6300.
d. Cooper; IG5361

C. Description: Straight blade; equipment grounding contacts shall be connected only to the 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.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

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

a. Cooper; GF20.
b. Pass & Seymour; 2084.
c. Leviton; GFNL1
d. Hubbell; GFRST83

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

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

a. Cooper Crouse-Hinds.
b. EGS/Appleton Electric.
c. Killark; a division of Hubbell Inc.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

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

a. Cooper; L520R.
b. Hubbell; HBL2310.
c. Leviton; 2310.
d. Pass & Seymour; L520-R.

2.6 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

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

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:

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

a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

2.8 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

.
1. Material for Finished Spaces: 0.035-inch- thick, jumbo satin-finished stainless steel.
2. Material for Damp Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof in use Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.9 FLOOR SERVICE FITTINGS

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

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
3. Thomas & Betts Corporation.
4. FRS
5. Wiremold Company (The).

B. Type: Modular, flush-type, dual-service units suitable for wiring method used.

C. Compartments: Barrier separates power from voice and data communication cabling.

D. Service Plate: Rectangular solid brass with satin finish.

E. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

F. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 6A jacks for FTP cable per Division 27.

2.10 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Gray, unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
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. Pig tailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
10. Make terminations at devices with Crimp on Fork Tongue Terminal.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Device Plates: 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. 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, multi gang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section 260553.

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Ground Impedance: Values of up to 2 ohms are acceptable.
3. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
4. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

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SECTION 26 28 16 - 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. Molded-case circuit breakers (MCCBs).
4. Molded-case switches.
5. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

1.4 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."

1.5 SUBMITTALS

B. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. 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.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

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

C. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 PRODUCTS

2.1 NONFUSIBLE SWITCHES

B. Basis-of-Design Product: Subject to compliance with requirements, provide Square D or comparable product by one of the following:

1. Eaton Electrical Inc
2. ABB.
3. Siemens Energy & Automation, Inc.

C. Type HD, Heavy Duty, 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. 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. Where indicated.
3. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D or comparable product by one of the following:

1. Eaton Electrical
2. ABB
3. Siemens Energy & Automation, Inc.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: 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.

D. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 12.
2. Outdoor Locations: NEMA 250, Type 4X
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X.

PART 2 - 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.

3.2 INSTALLATION

A. Install switches so they are rigidly supported and readily accessible. Where mounted on stud walls, provide a plywood backboard secured to the studs with the switch secured to the backboard. Provide stainless steel mounting channel or phenolic spacers to give nominal 1/2-inch separation from concrete walls in wet or damp locations.

B. Switches are non-fused type, unless Drawings note otherwise, or the switch is used as a disconnect for an item of equipment with a maximum fuse size designated on the nameplate. In such cases, provide fusible type with appropriate fuse. If fusible switches protect conductors with an ampacity less than the rating of the switch, provide a nameplate on the inside front cover of the switch designating the maximum allowable fusing.

C. For disconnect switches serving motors with space heaters, provide lamecoid nameplate engraved "WARNING - Motor space heater energized with switch open".

D. Install fuses in fusible devices.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section 260553.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 26 29 13.03 - MANUAL AND MAGNETIC MOTOR 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

A. Section Includes:

1. Manual motor controllers.
2. Enclosed full-voltage magnetic motor controllers.
3. Combination full-voltage magnetic motor controllers.
4. Enclosures.
5. Accessories.
6. Identification.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. NC: Normally closed.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SCPD: Short-circuit protective device.

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.

B. Shop Drawings: For each type of magnetic controller.

1. Include plans, elevations, sections, and mounting details.

2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

    a. Listing document proving Type 2 coordination.

7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for magnetic controllers, 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 magnetic controllers to include in 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 magnetic controllers and installed components.

b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
c. Manufacturer's written instructions for setting field-adjustable overload relays.
d. 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.
e. 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. 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.
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: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 W per controller and connect factory-installed space heaters to temporary electrical service.

1.10 FIELD CONDITIONS

A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than23 deg F (minus 5 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m) for electromagnetic and manual devices.
3. The effect of solar radiation is not significant.

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 use.

B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.

C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

D. Seismic Performance: Magnetic controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the controller will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Manufacturers: Subject to compliance with requirements. Provide products by one of the following:
   a. General Electric
   b. Schneider Electric
   c. Eaton

2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
3. Configuration: Nonreversing.
4. Surface mounting.
5. Red pilot light.

2.3 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

B. Manufacturers: Subject to compliance with requirements. Provide products by one of the following:
   a. ABB
   b. Schneider Electric
   c. Eaton
   d. Allen-Bradley
   e. Siemens

C. Standard: Comply with NEMA ICS 2, general purpose, Class A.

D. Configuration: Non-reversing.

E. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.

   1. Operating Voltage: Manufacturer's standard, unless indicated.

F. Control Power:

   1. For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

      a. Spare CPT Capacity as Indicated on Drawings: 100 VA.

G. Overload Relays:

   1. Solid-State Overload Relay:

      a. Switch or dial selectable for motor-running overload protection.
      b. Sensors in each phase.
      c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

H. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

I. MCCB Disconnecting Means:

   1. UL 489 and NEMA AB 3, 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.
   2. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   3. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.4 ENCLOSURES

A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.

B. The construction of the enclosures shall comply with NEMA ICS 6.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.

    a. Push Buttons: As indicated in the controller schedule.
    b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours**;** non-resettable.
3. Meters: Panel type, 2-1/2-inch (64-mm) minimum size with 90- or 120-degree scale and plus or minus two percent accuracy. Where indicated, provide selector switches with an off position.

B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.

1. Phase-failure.
2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

2.6 IDENTIFICATION

A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

B. Arc-Flash Warning Labels:

1. Comply with requirements in Section 260573. Produce a 3.5-by-5-inch (89-by-127-mm) self-adhesive equipment label for each work location included in the analysis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.

C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

E. 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.

F. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

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 tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:

        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

    f. Motor-Running Protection:

        1) Verify overload element rating is correct for its application.

2) If motor-running protection is provided by fuses, verify correct fuse rating.

g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with 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 according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

END OF SECTION 262913.03

SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR 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

A. This Section includes providing solid-state, PWM, Variable Frequency Drives (VFD) provided by driven equipment suppliers from the specifications within. The FVDs are for speed control of three-phase, squirrel-cage induction motors.

B. The driven equipment supplier has the responsibility for providing system VFD equipment matching the process driven equipment with in the equipment specification sections.

1.3 DEFINITIONS

C. IGBT: Integrated gate bipolar transistor.

D. LAN: Local area network.

E. PID: Control action, proportional plus integral plus derivative.

F. PWM: Pulse-width modulated.

G. VFD: Variable frequency drive.

1.4 SUBMITTALS

A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD.

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. Include the following:

    a. Each installed unit's type and details.
    b. Nameplate legends.
    c. Short-circuit current rating of integrated unit.
    d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.

e. Features, characteristics, ratings, and factory settings of each motor-control center unit.

2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD 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. Manufacturer Seismic Qualification Certification: Submit certification that VFDs, accessories, and components will withstand seismic forces defined in Division 26 Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. 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. 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. 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.

E. Qualification Data: For manufacturer.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for VFDs and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

H. 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.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

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

D. Comply with NFPA 70.

E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, minimum clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:

1. Ambient Temperature: 0 to 50 deg C.
2. Humidity: Less than 90 percent (noncondensing).
3. Altitude: Not exceeding 3300 feet.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.8 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 EXTRA MATERIALS

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

1. Spare Fuses: Furnish one spare for every five installed, but no less than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Allen Bradley.

2. ABB

3. Eaton

4. Approved equal

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency. Unit shall have microprocessor-based controls.

1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. 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.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

D. Unit Operating Requirements:

1. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
2. Input frequency tolerance of 50/60 Hz, plus or minus 6 percent.
3. Minimum Efficiency: 96 percent at 60 Hz, full load.
4. Minimum Displacement Primary-Side Power Factor: 96 percent.
5. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
6. Starting Torque: 100 percent of rated torque or as indicated.
7. Speed Regulation: Plus or minus 1 percent.

E. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.

1. Electrical Signal: 4 to 20 mA at 24 V.

F. 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: 2 to a minimum of 22 seconds.
4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

G. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 20 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor overtemperature fault.

H. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

I. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

J. 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.

K. Status Lights: Door-mounted LED indicators shall indicate the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

L. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

M. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

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 (VFC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

N. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:

    a. 0 to 10-V dc.
    b. 0-20 or 4-20 mA.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.
    e. RS485.
    f. Keypad display for local hand operation.

3. Output Signal Interface:

    a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:

        1) Output frequency (Hz).
        2) Output current (load).
        3) DC-link voltage (VDC).
        4) Motor torque (percent).
        5) Motor speed (rpm).
        6) Set-point frequency (Hz).

4. Remote Indication Interface: A minimum of 2 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.

O. Communications: Provide an Ethernet interface allowing VFD to be used with an external system within a LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via BMS control. Provide capability for VFD to retain these settings within the nonvolatile memory.

P. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

2.4 PROTECTIVE FEATURES

A. Input molded case circuit breaker rated 30,000 AIC to disconnect the drive and control circuits.

B. Output contactor(s) to disconnect the armature and field when the drive is off.

C. Solid state protective circuits with diagnostic capabilities for over/under voltage, inverse time and instantaneous overcurrent, phase loss, and thermal overload.

D. Where motor temperature switches are specified provide circuitry to shut down the drive if the switch opens.

2.5 ENCLOSURES

A. Free Standing 30-inch wide x 20-inch deep x 90-inch tall minimum

B. NEMA Type 1A.

C. Provided by drive manufacturer to enclose all drive components as a complete UL list package.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. 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.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Line Reactors as required to meet harmonic requirements and drive motor and feeder overvoltage transient and reflected wave overvoltage issues.

F. Integral disconnect and overcurrent for input power in enclosure to drive and bypass starter if bypass installed

G. Standard Displays:

1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

H. 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.

I. Current-Sensing, Phase-Failure Relays for Bypass Controller: Solid-state sensing circuit with isolated output contacts for hard-wired connection; arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage; with adjustable response delay.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFDs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Mount VFD on 4-inch concrete housekeeping pad. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

3.2 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Controller Fuses: Install fuses in each fusible switch. Comply with manufacturer’s requirements.

3.4 IDENTIFICATION

A. Identify VFDs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices according to Division 26 Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

3.6 CONNECTIONS

A. Conduit and cable installation shall be bottom entry

B. Ground equipment according to Division 26 260526 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
3. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

3.8 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 DEMONSTRATION

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

END OF SECTION 262923

SECTION 26 32 13 - DIESEL EMERGENCY ENGINE GENERATORS

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. This Section includes packaged engine-generator sets for standby power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted double wall diesel fuel tank
4. Unit-mounted control and monitoring.
5. Sound attenuated outdoor enclosure.

B. Related Sections include the following:

1. Section 262413, "Distribution Switchboards - Automatic Transfer Switch", including sensors and relays to initiate automatic-starting and - stopping signals for engine-generator sets.

1.3 ACTION SUBMITTALS

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

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in "Operation and Maintenance Data", specification section include the following:

1. 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.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

B. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

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

D. Comply with ASME B15.1.

E. Comply with NFPA 37.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110 requirements.

I. Comply with UL 2200.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

K. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 3200 feet

1.7 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which 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: 2 years from date of completion.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. Kohler
2. Caterpillar; Engine Div.
3. Onan/Cummins Power Generation

2.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: As indicated
2. Output Connections: As indicated.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set 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 3-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.

2.3 ENGINE

A. Fuel: No. 2 Diesel

B. Rated Engine Speed: 1800 rpm.

C. Construction: Heavy duty industrial type; water cooled; compression ignition diesel engine. Engine shall be 4-cycle, solid injection, vertical in-line or V-type, 12 cylinders maximum. Provide single piece, cast iron block fitted with removable wet cylinder liners of close-grained alloy cast iron; single piece drop forge steel crankshaft; precision insert, steel backed tri-metal bearings; forged connecting rods; cast pistons with positive pressure oil cooling.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: 208V, single phase Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Solid state isochronous type with steady state speed regulation of 0.5 percent and transient speed regulation of three cycles maximum from no load to full load with two second maximum recovery to steady state.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set 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-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and no collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler/Silencer: Residential 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 18 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 95 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" 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: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" 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 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. 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 C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    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 SUB-BASE FUEL TANK

A. Comply with NFPA 30 and with UL 142.

B. Tank design shall duel wall, secondary containment, heavy construction 0.24-inch steel plate, side channels 0.16-inch sheet steel, rear and right side stub-up access. Welded steel containment basin (minimum of 110% of primary tank capacity. Interior tank surface shall be coated with a solvent-based thin film to prevent rust. Locate tank fill nozzle as indicated on the drawings.

C. Capacity: Fuel for 24 hours continuous operation, 200 gallon minimum.

D. Electronic Leak Detection System.

E. Fuel Level switch with alarm and shutdown.

F. Tank design shall provide capacity for thermal expansion of fuel. Features include the following:
    1. Direct reading fuel level indicator.
    2. 4-inch lockable flip top fill cap.
    3. Compatible with sound attenuated enclosure as described below. .

2.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

G. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Engine high-temperature shutdown.
2. Lube-oil, low-pressure shutdown.
3. Over speed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature pre-alarm.
6. Lube-oil, low-pressure pre-alarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.

H. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect

so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.7 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 or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Drip proof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

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. Sub transient Reactance: 12 percent, maximum.

2.8 SOUND ATTENUATED ENCLOSURE

A. Description: Vandal-resistant, weatherproof sound attenuated 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.

B. Description: Prefabricated or pre-engineered enclosure with the following features:

1. Construction: Galvanized-steel, metal-clad, integral structural-steel-framed building erected on concrete foundation.
2. Structural Design and Anchorage: Comply with ASCE 7 for wind loads.
3. Space Heater: Thermostatically controlled and sized to prevent condensation.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents.
5. Lockable double access doors capable of 180-degree swing.
6. Lube oil and coolant drain pipes to exterior of enclosure and terminate with drain valves.
7. Ventilation: Louvers equipped with bird screen and filter arranged to permit air circulation while excluding exterior dust, birds, and rodents.
8. Thermal Insulation: Manufacturer's sound attenuated materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
9. Muffler Location: Within enclosure.

C. Sound Pressure Levels (Maximum)

1. 83.3 dBA at 3.3–feet
2. 72 dBA at 23–feet
3. 66 dBA at 49.2–feet

D. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

E. Auxiliary Circuit Breaker: NEMA AB-1; molded case type; NEMA 1 unit mounted enclosure; 30 amp; 3-pole; 10,000 AIC. Breaker shall disconnect 120/208 volt, 3-phase, 4-wire incoming power for coolant heater, battery charger, and other auxiliary devices.

F. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

G. Convenience Outlets: Factory wired GFCI. Arrange for external electrical connection.

2.9 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- 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.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set 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 set 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. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
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 of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

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."

3.4 IDENTIFICATION

A. Identify system components according Section 260553 "Identification for Electrical Systems".

3.5 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. Report results in writing.

B. Perform tests and inspections and prepare test reports.

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. Load Test: Provide full load test utilizing portable load bank, for four hours minimum. Provide fuel for test.

D. Record in 20 minute intervals during four hour test:

1. Kilowatts
2. Amps
3. Voltage
4. Coolant temperature
5. Oil pressure
6. Frequency

E. Test alarm and shutdown circuits by simulating conditions.

F. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection.
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 Emissions Test: Comply with applicable government test criteria.
7. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations and compare measured levels with required values.

G. Coordinate tests with tests for transfer switches and run them concurrently.

H. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

I. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

J. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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 Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. 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 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

SECTION 26 41 13 - 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.

B. This section applies to work in all of Division 26.

1.2 SECTION INCLUDES:

A. Lightning protection as indicated and for the following:

1. Mixing Building
2. Two Storage Tanks
3. Truck Canopy

1.3 DEFINITIONS

A. UL: Underwriters Laboratory.

B. NRTL: National recognized testing laboratory.

1.4 SUBMITTALS

A. Product Data: For air terminals and mounting accessories.

B. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL.

D. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

E. Field inspection reports indicating compliance with specified requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who is certified by UL as a Master Installer/Designer.

B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Automatic Lightning Protection.
2. ERICO International Corporation.
3. Harger Lightning Protection, Inc.
4. Heary Bros. Lightning Protection Co. Inc.
5. Independent Protection Co.
6. Robbins Lightning Inc.
7. Thompson Lightning Protection, Inc.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Roof-Mounting Air Terminals: NFPA Class II, aluminum or copper, and solid, unless otherwise indicated.

1. Single-Membrane, Roof-Mounting Air Terminals: Designed for single-membrane roof materials.

2. Standing Seam Roof-Mounting Air Terminal: Designed for standing seam roofs

C. Stack-Mounting Air Terminals: Solid aluminum or copper.

D. Roof conductor: Aluminum or copper Class II

E. Down conductors: Coper only Class II.

F. Dissimilar metal connections:

1. Connections to steel columns exothermic weld only

2. Connections aluminum to copper conductors UL 96 listed compression connectors.

G. Conductor supports: Aluminum or copper alloy

1. Single-Membrane, Roof-Mounting Air Terminals: Designed for single-membrane roof materials.

2. Standing Seam Roof-Mounting Air Terminal: Designed for standing seam roofs

H. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 26 Section 260526 "Grounding and Bonding for Electrical Systems" and with standards referenced in this Section.

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 sharp bends and narrow loops.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view from exterior locations at grade within 200 feet of building.
5. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above roofs.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions. Mounting shall not penetrate roofs.

F. Air Terminals on Standing Seam Roofing: Shall be mounted to the seams and not attached to roof surface and be designed for the application. Mounting shall not penetrate roofs.

G. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

H. A counterpoise installation based on requirements in Division 26 Section 260526 "Grounding and Bonding for Electrical Systems" may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum requirements in NFPA 780.

1. Bond ground terminals to counterpoise conductor.
2. Bond grounded metal bodies on building within 12 feet of ground to counterpoise conductor.
3. Bond grounded metal bodies on building within 12 feet of roof to interconnecting loop at eave level or above.

I. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 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.

3.3 FIELD QUALITY CONTROL

A. UL Inspection: Provide inspections as required to obtain a UL Master Label for system.

B. Provide an inspection by an inspector certified by UL to obtain an UL certification.

END OF SECTION 264113

SECTION 26 43 13 - 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 Distribution Switchboards-Automatic Transfer Switch for integral SPDs installed by manufacturer.
2. Section 262416 Panelboards for integral SPDs installed by panelboard 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 five 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 on of the following:
   1. Surge Suppressor, Inc.
   2. Eaton Electrical
   3. Schneider Electric
   4. Or Approved Equal

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 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 160 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 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 100 kA.
   6. Inominal Rating: 20 kA.

2.2 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Manufacturers: Subject to compliance with requirements. Provide products by on of the following:
   1. Eaton Inc.
   2. RTEC Corporation
   3. Schneider Electric
   4. Transtector

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 2 A 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 100 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 100 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.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 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 the 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. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 26 51 19 - LED 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. Downlight.
   2. Linear industrial.
   3. Lowbay.
   4. Recessed, linear.
   5. Strip light.
   6. Surface mount, linear.
   7. Suspended, linear.
   8. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
   9. Luminaire supports.
   10. 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.

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**,** complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

    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 (300 mm) of the plane of the luminaires.
4. Structural members to which equipment, and/or 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.

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. LED Arrays: Ten for every 100 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 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 Architect'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 Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 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.

1.11 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 Architect prior to the start of luminaire installation.

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 (Minus 15 to plus 40 deg C).

1. Relative Humidity: Zero to 95 percent.

D. Altitude: Sea level to 1000 feet (300 m).

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. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI.

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 DOWNLIGHT

A. Refer to Luminaire schedule.

B. Nominal Operating Voltage: 277 V ac.

C. Lamp:

1. Minimum (lm): as indicated.
2. Minimum allowable efficacy of (lm/W): as indicated.
3. CRI: as indicated. CCT: as indicated.
4. Rated lamp life of 35,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

a. Bulb shape complying with ANSI C78.79.
b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

E. 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.

F. Diffusers and Globes:

1. Fixed lens.
2. Light distribution: as indicated.
3. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
4. Glass: Annealed crystal glass unless otherwise indicated.
5. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. Recessed luminaires shall comply with NEMA LE 4.

2.4 LINEAR INDUSTRIAL

A. Refer to Luminaire schedule.

B. Lamp:

1. Minimum (lm): as indicated.
2. Minimum allowable efficacy of (lm/W): as indicated.
3. CRI: as indicated. CCT: as indicated.
4. Rated lamp life of 35,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

   a. Bulb shape complying with ANSI C78.79.
   b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

F. With integral mounting provisions.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.

2.5 LOWBAY

A. Refer to Luminaire schedule.

B. Nominal Operating Voltage: 277 V ac.

C. Lamp:

1. Minimum (lm): as indicated.
2. Minimum (lm/W): as indicated.
3. CRI: as indicated. CCT: as indicated.
4. Rated lamp life of 35,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are

designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.6 RECESSED, LINEAR

A. Refer to Luminaire schedule.

B. Nominal Operating Voltage: 277 V ac.

C. Lamp:

1. Minimum (lm): as indicated.
2. Minimum allowable efficacy of (lm/W): as indicated.
3. CRI: as indicated. CCT: as indicated.
4. Rated lamp life of 35,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:
    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.
8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. NEMA LE 4.

2.7 STRIP LIGHT

A. Refer to Luminaire schedule.

B. Nominal Operating Voltage: 277 V ac.

C. Lamp:

1. Minimum (lm): as indicated.
2. Minimum allowable efficacy of (lm/W): as indicated.
3. CRI: as indicated. CCT: as indicated.
4. Rated lamp life of 35,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping of luminaire without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.8 SURFACE MOUNT, LINEAR

A. Refer to Luminaire schedule.

B. Nominal Operating Voltage: 277 V ac.

C. Lamp:

1. Minimum (lm): as indicated.
2. Minimum allowable efficacy of (lm/W): as indicated.
3. CRI: as indicated. CCT: as indicated.
4. Rated lamp life of 35,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.9 SUSPENDED, LINEAR

A. Refer to Luminaire schedule:

B. Nominal Operating Voltage: 277 V ac.

C. Lamp:

1. Minimum (lm): as indicated.
2. Minimum allowable efficacy of (lm/W): as indicated.
3. CRI: as indicated. CCT: as indicated.
4. Rated lamp life of 35,000 hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:

    a. Bulb shape complying with ANSI C78.79.
    b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.
3. With integral mounting provisions.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

G. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.10 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 A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209.

2.11 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.

2.12 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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

D. Rod Hangers: 3/16-inch (5-mm) 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.

2.13 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Refer to Luminaire schedule.

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 (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) 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.

2.14 Adjustable window slide for adjusting on-off set points.

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 Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. 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.

F. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:

1. Ceiling Mount:
   a. Pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports.

2. Pendants and Rods: Where longer than 48 inches (1200 mm), 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.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

I. 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 260923 "Lighting Control Devices."

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 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 Architect.

END OF SECTION 265119

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SECTION 270528 - PATHWAYS FOR COMMUNICATION SYSTEMS GENERAL

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. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Surface pathways.
7. Boxes, enclosures, and cabinets.
8. Handholes and boxes for exterior underground cabling.

B. Related Requirements:
1. Section 260526 "Grounding and Bonding for Electrical Systems."
2. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
3. Section 260533 "Raceway and Boxes for Electrical Systems."

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:
1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. General: Comply with Section 014300 “Quality Requirements.”

B. Coordination Drawings: Pathway 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 pathway groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
   3. Utilities and other civil work.

C. Reports: Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. AFC Cable Systems, Inc.
   2. Allied Tube & Conduit.
   3. Alpha Wire Company.
   4. Anamet Electrical, Inc.
   5. Electri-Flex Company.
   6. O-Z/Gedney.
   7. Picoma Industries.
   8. Republic Conduit.
   9. Robroy Industries.
   10. Southwire Company.
   11. Thomas & Betts Corporation.
   12. Western Tube and Conduit Corporation.
   13. Wheatland Tube Company.

B. General Requirements for Metal Conduits and Fittings:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with ANSI/TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

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

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
   2. Fittings for EMT:

a. Material: steel.
b. Type: compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. 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. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Anamet Electrical, Inc.
4. Arnco Corporation.
5. CANTEX Inc.
6. CertainTeed Corporation.
7. Condux International, Inc.
8. Electri-Flex Company.
9. Kraloy.
10. Lamson & Sessions; Carlon Electrical Products.
11. Niedax-Kleinhuis USA, Inc.
12. RACO; Hubbell.
13. Thomas & Betts Corporation.

B. General Requirements for Nonmetallic Conduits and Fittings:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Section 260533 "Raceway and Boxes for Electrical Systems."

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651B.

F. RTRC: Comply with UL 1684A and NEMA TC 14.

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

H. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

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

1. Maxcell.

B. Description: Comply with UL 2024; flexible-type pathway, approved for plenum, riser or general-use installation unless otherwise indicated.
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with ANSI/TIA-569-D.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Mono-Systems, Inc.
   4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4 or Type 12 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.
   2. Comply with ANSI/TIA-569-D.

C. 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.

D. Wireway Covers: Hinged type, Screw-cover type or Flanged-and-gasketed type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Allied Moulded Products, Inc.
   2. Hoffman.
   3. Lamson & Sessions; Carlon Electrical Products.
   4. Niedax-Kleinhuis USA, Inc.

B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with ANSI/TIA-569-D.

C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

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

E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 SURFACE PATHWAYS

A. General Requirements for Surface Pathways:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with ANSI/TIA-569-D.

B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect or Prime coated, ready for field painting.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Mono-Systems, Inc.
      b. Niedax-Kleinhuis USA, Inc.
      c. Panduit Corp.
      d. Wiremold / Legrand.

C. Surface Nonmetallic Pathways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL-94 V-0 requirements for self-extinguishing characteristics.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Lamson & Sessions; Carlon Electrical Products.
      b. Mono-Systems, Inc.
      c. Panduit Corp.
      d. Quazite:Hubbell Power Systems, Inc.
      e. Wiremold / Legrand.

2.7 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Adalet.
   2. Cooper Technologies Company; Cooper Crouse-Hinds.
   3. EGS/Appleton Electric.
   4. Erickson Electrical Equipment Company.
   5. Hoffman.
   6. Lamson & Sessions; Carlon Electrical Products.
   7. Milbank Manufacturing Co.
   8. Molex; Woodhead Brand.
   9. Mono-Systems, Inc.
   10. O-Z/Gedney.
   11. Quazite:Hubbell Power Systems, Inc.
   12. RACO; Hubbell.
   13. Robroy Industries.
   14. Spring City Electrical Manufacturing Company.
   15. Stahlin Non-Metallic Enclosures.
   16. Thomas & Betts Corporation.
   17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Comply with ANSI/TIA-569-D.
   2. 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, ferrous alloy or aluminum, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

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

G. Gangable boxes are allowed.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

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.
   3. Comply with ANSI/TIA-569-D.

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, provide products by the following:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. NewBasis.
      d. Oldcastle Precast, Inc; Christy Concrete Products.
      e. Quazite: Hubbell Power System, Inc; Hubbell Power Systems.
      f. Synertech Moulded Products.
   2. Standard: Comply with SCTE 77.
   3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
   4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location. Refer to drawing details for load ratings.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, "COMMUNICATIONS."
   7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.9 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 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed Conduit: GRC or IMC.
   2. Concealed Conduit, Aboveground: GRC, IMC, EMT or RNC, Type EPC-40-PVC.
   3. Underground Conduit: RNC, Type EPC-40-PVC or Type EPC-80-PVC, direct buried concrete encased.
   4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R or Type 4X based on location.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT or RNC.
   2. Exposed, Not Subject to Severe Physical Damage: EMT or RNC identified for such use.
   3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Pathway locations include the following:
      a. Loading dock.
      b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT, RNC, Type EPC-40-PVC or innerduct.
   5. Damp or Wet Locations: GRC or IMC.
   6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
   7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
   8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: EMT.
   9. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4X stainless steel or nonmetallic in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch.

D. Pathway Fittings: Compatible with pathways 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. EMT: Use compression fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and ANSI/TIA-569-D for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

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

F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

G. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Pathways 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 pathways to reinforcement at maximum 10-foot intervals.
   2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
   3. Arrange pathways to keep a minimum of 1 inches of concrete cover in all directions.
   4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
   5. Change from ENT to RNC, Type EPC-40-PVC, GRC or IMC before rising above floor.

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

K. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. 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.

O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

P. Install pull wires in empty pathways. 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 pathways designated as spare above grade alongside pathways in use.

Q. Surface Pathways:
1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

R. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

S. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway sealing fittings according to NFPA 70.

T. Install devices to seal pathway 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 pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

V. 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 and EMT 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 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.
   d. Interstitial Spaces: 135 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.

W. 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.

X. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. 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.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit.
2. 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.
3. 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.
4. 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.
5. 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.

6. 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.

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 FIRESTOPPING

A. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or 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 270528

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SECTION 271300 - COMMUNICATIONS BACKBONE 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. Pathways.
2. Optical fiber cable.
3. Optical fiber cable hardware.
4. Identification products.
5. Source quality control

B. Related Sections:
1. Section 270528 "Pathways for Communications Systems - General."

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. NRTL: Nationally Recognized Testing Laboratory.

D. RCDD: Registered Communications Distribution Designer.

E. TDMM: Telecommunications Distribution Methods Manual.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between the South Deicing Complex building Comm/Data Room and the Mixing Building equipment rack. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings:
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics including the following:
a. Cross-connects.
b. Patch panels.

c. Patch cords.

4. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:
1. Plans showing actual routing and description of cabling.

1.8 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. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications:
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable NRTL.
1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

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

E. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-D.

F. Grounding: Comply with ANSI/TIA-607-C.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer (OTDR) to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.11 PROJECT CONDITIONS

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

1.12 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with civil work, utilities and service suppliers.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with ANSI/TIA-569-D and Section 270528 “Pathways for Communications Systems.

B. Conduit and Boxes: Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
   1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden CDT Network Division.
   2. Berk-Tek; a Nexans company.
   3. CommScope, Inc.
   4. Corning Cable Systems.
   5. Panduit.
   6. Siemon.
   7. Superior Essex Inc.

B. Description: Singlemode OS2, loose tube (gel free or gel filled), optical fiber cable.
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with ANSI/TIA-568.3-D for performance specifications.
   3. Comply with ANSI/TIA-492AAAA-B or ANSI/TIA-492AAAA-A for detailed specifications.
   4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
      a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

5. Conductive cable shall be steel or aluminum armored type.
6. Maximum Attenuation: 1.00 dB/km at 1310 nm; 1.0 dB/km at 1550 nm.
7. Contractor must obtain Owner approval for final type installed at each location. Owner-preferred optical fiber cable is fire resistant OFNP with rodent protection.

C. Jacket:
1. Jacket Color: Black with solar radiation protection, except for Delta cable, which shall be one (1) red fiber and one (1) blue fiber jacket.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.
4. Low smoke zero halogen (LSZH).

2.3 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ADC.
2. American Technology Systems Industries, Inc.
3. Berk-Tek; a Nexans company.
4. Corning Cable Systems.
5. Dynacom Corporation.
6. Hubbell Premise Wiring.
7. Molex Premise Networks; a division of Molex, Inc.
8. Nordex/CDT; a subsidiary of Cable Design Technologies.
9. Optical Connectivity Solutions Division; Emerson Network Power.
10. Siemon Co. (The).

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 48-inch lengths.

D. Cable Connecting Hardware:
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-10-B. Comply with ANSI/TIA-568.3-D.
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.4 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to ANSI/TIA-568.1-D.

C. Factory test single mode optical fiber cables according to ANSI/TIA-526-7-C and ANSI/TIA-568.3-D.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways except within cabinets.
   1. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

1. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA-569-D.

B. Comply with ANSI/TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Comply with requirements in Section 270528 “Pathways for Communications Systems” for installation of conduits and wireways.

D. Install manufactured conduit sweeps and long-radius elbows whenever possible.

E. Install fiber optic cabling within flexible, multi-celled, fabric innerduct as manufactured by MaxCell.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with ANSI/TIA-568.1-D.
   2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated patch panels.
   4. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.

6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. In the communications equipment room, install a 10-foot long service loop on each end of cable.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

3.5 FIRESTOPPING

A. Comply with ANSI/TIA-569-D, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 FIELD QUALITY CONTROL

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

B. Perform the following tests and inspections:
1. Visually inspect cable placement, cable termination, equipment and patch cords, and labeling of all components.
2. Optical Fiber Cable Tests:
   a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568.1-D. 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) Single mode backbone link measurements: Test at 850/1310 or 1300/1550 nm in one direction according to ANSI/TIA-526-7-C, Method B, One Reference Jumper.
      2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA-568.3-D.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports and submit for approval.

3.7 WARRANTY

A. A twenty (25) year warranty available for the structured cabling system (Fiber Optics and Copper infrastructure) shall be provided for an end to end channel installation which covers application assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.

B. Provide Warranty Certificate issued by the manufacturer of the backbone infrastructure

END OF SECTION 271300

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SECTION 28 31 00

FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide fire detection and alarm as indicated and in compliance with Contract Documents.

B. Provide, test, and place into operating condition an electrically operated, microprocessor based, UL listed, four-wire, analog/addressable, electrically supervised fire detection and evacuation system as indicated and specified.

C. The System shall include, but not be limited to: Fire Alarm Control Panel (FACP) (or panels required for each building), remote Annunciator Command Center (ACC), power supplies and fire alarm initiating and notification devices including addressable monitor and control modules.

D. The fire alarm system shall include conduit, wire, fittings, and accessories required to provide a complete operating system.

E. Connect fire alarm control panels in a local area network via twisted pair cable for data communication with other areas. Display local information at each network node and the entire network monitored at the network remote annunciator panel.

F. All charges and fees required by the local Authority having jurisdiction (AHJ) to inspect the installation and implement fire alarm notification are to be included by the Contractor under this section at no additional cost to the Owner.

G. System shall include a voice evacuation panel in compliance with NFPA 72 requirements.

1.02 REFERENCES:

A. ASME International (ASME):

1. A17.1: Safety Code for Elevators and Escalators

B. Factory Mutual (FM):

1. P7825: Approved Guide

C. Institute of Electrical and Electronics Engineers (IEEE):

1. C62.41.1: IEEE Guide on the Surges Environment in Low-Voltage (1000V and Less) AC Power Circuits.

2. C62.41.2: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

2. 72: National Fire Alarm Code

3. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems

4. 101: Life Safety Code.

E. Underwriters' Laboratories (UL)

1. Fire Protection Equipment Directory

2. 268: Standard for Smoke Detectors for Fire Alarm Signaling Systems

3. 464: Standard for Audible Signal Appliances

4. 864: Control Units for Fire Protective Signaling Systems

5. 1971: Signaling Devices for the Hearing Impaired

G. State and Local Building Codes.

1.03 SYSTEM DESCRIPTION:

A. Type of System:

1. Fire Alarm System: The fire alarm system shall operate as a low voltage analog/addressable type system and shall automatically initiate fire alarm signals whenever any manual or automatic fire detecting devices are placed into an alarm mode. The system shall indicate areas of alarm and sound local alarms. Initiating loops and notification loops shall be wired as four-wire class A loops. Initiating loops and notification loops shall be complete with necessary switches, meters, relays, pilot lights, surge arresters and addressable modules as required. A minimum of one thermal cut-out or fuse and surge arrestor for every notification circuit shall be provided. An annunciator shall indicate the specific location of the fire.

2. The system shall be capable of operating with a single break or ground fault condition in the initiating or alarm sounding circuits.

3. Evacuation Alarms: Coded evacuation alarm: A fire alarm signal shall be employed for notifying the occupants to evacuate.

4. Trouble Signals: During abnormal conditions such as an open wire or a ground fault, or where both conditions occur at one point, the system shall be capable of automatically transmitting clear, intelligible trouble signals.

5. Power Supply for the System: A dedicated branch-circuit for supplying power to the alarm system shall be provided for the Fire Alarm Control Panel (FACP). The branch circuits shall be automatically energized from an auxiliary electrical power system during failures of the normal power supply. Provide battery backup power consisting of rechargeable, sealed type storage batteries and battery charger.

6. The system shall interface to HVAC system and other building systems as shown on the Contract Drawings and required by applicable codes to provide all required monitoring and control functions.

B. Sequence of Operation:

1. When a fire-alarm condition is detected by one of the system initiating devices, the following functions shall immediately occur:

   a. Automatic programs assigned to the alarm point shall be executed and the associated indicating devices and relays activated.

   b. An exterior strobe at the building in alarm shall energize and the fire alarm notification devices in only that building shall operate.

   c. The system alarm on the Fire Alarm Control Panel and Remote Annunciator Command Center will indicate condition.

   d. The alarm shall be signaled automatically to the local Central Station Monitoring System

   e. Shutdown of HVAC equipment and associated exhaust and pressurization operations to be initiated.

2. When a trouble condition is detected by one of the system initiating or indicating circuits, the following functions shall immediately occur:

   a. System Trouble will be indicted on FACP and Annunciator Command Center.

   b. A local trouble-sounding device in the FACP and Annunciator Command Control shall be activated. This sound shall be distinct from the alarm sound.

   c. The appropriate message will appear on the LCD display at the FACP and Annunciator Command Center.

1.04 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Copy of this specification section with addenda and all referenced specification sections with addenda check-mark each paragraph to indicate specification compliance or indicate deviation and reason for deviation.

   a. Failure to include a copy of the marked-up specification sections will result in return of the entire submittal with no further review and consideration.

2. Installer and system supplier qualifications and list of three similar projects with name and phone number of contact person.

3. Complete list of equipment and materials, including manufacturer's descriptive and technical literature, catalog cuts. Shop drawings shall contain complete conduit riser diagrams, wiring diagrams, and schematic diagrams for the equipment furnished. Riser diagrams shall identify cable sizes and quantities, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

4. Manufacturer’s printed installation instructions.

5. Battery capacity calculations to demonstrate that the battery size selected is a minimum of 125 percent of the calculated requirement. Calculation to include supervisory power requirements for all equipment, and alarm power requirements for all equipment.

    a. Calculations to show amplifiers have sufficient capacity to simultaneously drive fire alarm speakers at their 1/2 watt tap plus 50 percent spare capacity.

6. Wiring diagrams from the fire alarm system integrator or supplier differentiating clearly between factory and field installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Identify all diagrams to be specific to this project and distinguish between field and factory wiring.

B. Spare Parts Data:

1. After approval of the list of shop drawings, and not later than six months prior to the date of substantial completion, furnish copies of spare parts data for each different item of materials and equipment specified. The data shall include a complete list of parts and supplies with current unit prices and source of supply, a list of supplies that are either normally furnished at no extra cost with the purchase of the equipment, or specified to be furnished in accordance with paragraph Special Tools and Spare Parts and a list of additional items recommended by the manufacturer to assure efficient operation for a period of 120 days.

C. Operating and Maintenance Instruction Manuals:

1. At end of project, submit operating instruction manuals as specified in 01 78 23, outlining the step-by-step procedures required for system startup and operation shall be furnished. The instructions shall include the manufacturer's name, model number, service manual parts list and brief description of all equipment and their basic operating features.

2. Maintenance instructions manuals outlining maintenance procedures shall be furnished. The manual shall include a troubleshooting guide listing possible breakdown and repairs and a simplified connection wiring diagram for the system as installed. Provide the names, addresses, and telephone numbers of service organizations that provide technical assistance and carry stock of repair parts for the system to be furnished.

3. Performance Test Reports: Upon completion of the installed system, submit in booklet form field tests performed to prove compliance with the specified performance criteria. Each test report shall indicate the final position of controls.

D. Submit Certificate of Compliance, signed by manufacturers of fire alarm system components certifying that their products comply with specified requirements.

E. Submission to Authorities Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Upon receipt of comments from the authorities having jurisdiction, submit them for review. Resubmit if required to make clarifications or revisions to obtain approval.

1.05 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide one spare FACP mother board and 10 percent or a minimum of 2 devices of the total devices provided for this Contract as listed below.

1. Pull Stations.

2. Manual Pull Stations

3. Weatherproof Smoke Detectors.

4. Photoelectric Smoke Detectors.

5. Thermal Detectors, 135 degrees F.

6. Thermal Detectors, 190 degrees F.

7. Alarm Audible Devices.

8. Alarm Strobes.

C. Three sets of special tools necessary for the maintenance of the equipment shall be furnished. Two spare sets of fuses of each type and size required and five spare lamps for each type shall be furnished. Spare parts shall be listed on submittal list.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Standard Products: Material and equipment shall be the latest standard products of a single manufacturer regularly engaged in the manufacture of the product for the 5 years as a minimum.

C. Qualifications of the installer before commencing work: Submit information demonstrating that the supplier has successfully installed fire alarm systems of the same scope, type and design as specified.

1. Submit copies of all required Licenses and Bonds as required in the State having jurisdiction.

2. Employ on staff a minimum of one full time NICET level 2 Technicians or a professional engineer.

3. Certify that the completed system conforms with UL standards upon completion of the installation.

4. Ongoing maintenance and testing shall be provided to the Owner under a maintenance contract to maintain the UL listing.

D. Nameplates: The components of equipment shall have the manufacturer's name, address, type or style, and catalog number on a plate securely attached to the equipment.

E. Tags: Tags with stamped identification number shall be furnished for keys and locks. Tags shall be furnished to identify cable and conduit runs, wiring circuits, and all spare parts furnished for Authority's stock to maintain the system.

F. Keys and Locks: All locks shall be keyed alike.

G. Verification of Dimensions: Become familiar with details of the work and verify dimensions in the field.

H. Compliance: The fire detection and internal alarm system shall be configured in accordance with NFPA 72. The equipment furnished shall be compatible and be UL listed or FM approved or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

I. Accessibility: Enclosures shall be provided with ample gutter space to allow proper clearance between the enclosure and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate all units, and allow ample gutter space for interconnections of panels and field wires.

J. Verify conduit size and wire quantity, size, and type are suitable for the equipment supplied. Review the proper installation of each type of device with the equipment supplier.

K. Review selected arrangement with local fire authority for conformance with local and state requirements.

L. Onsite Technician Services:

1. Provide the services of a representative or technician certified by the manufacturer of the system, experienced in the installation and operation of the type of system provided.

2. The representative shall be licensed in the State if required by law.

3. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system, and Underwriters Laboratories listing certification requirements.

4. The technician shall provide the required instruction to the Owner’s personnel in the system operation, maintenance and programming.

5. Provide services of the manufacturer's service representative during installation, startup and testing, for a period of three working days plus travel where a working day is equivalent to 8 hours.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. Equipment placed into storage shall be protected from the weather, humidity and temperature variations, dirt, dust, and other contaminants.

1.08 SEISMIC DESIGN REQUIRMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. It shall be the responsibility of the manufacturer and supplier along with the Electrical Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Notifier

B. Honeywell

C. Simplex - Grinnell

2.02 MATERIAL AND EQUIPMENT:

A. General Product Description:

1. Each Fire-Alarm Control Panel (FACP) shall be capable of fire detection, equipment supervision and control, alarm management, and historical data collection and archiving.

B. Communications:

1. The FACP shall have sufficient memory to support its operating system and databases including:

a. Fire management

b. Alarm management

c. Historical/Trend Data

d. Maintenance Support Applications

e. Custom Processes

f. Operator I/O

2. Communication Ports: Provide data communication ports for simultaneous operation of devices such as industry standard printers, programming terminal, PC, transponder and annunciator.

3. Integrated On-Line Diagnostics: The FACP shall continuously perform self-diagnostics, communication diagnostics and diagnostics on all subsidiary equipment.

4. Surge and Transient Protection: Isolation shall be provided at all field point terminations to suppress induced voltage transients where required. Surge arrestors shall provide protection from all non-signal electrical surges that could cause damage to the equipment. Line surge arrestors shall be isolated from the electrical circuitry that they are protecting.

C. System Software Features:

1. Provide software to form a complete operating system as described in this specification shall be provided.

2. The software programs specified in this section shall be provided as an integral part of the panel and shall not be dependent upon any higher level computer for execution.

3. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. The control unit shall have capability of performing alarm analysis and signaling. At no time shall the panel's ability to report alarms be affected by operator activity.

4. Status Change Report: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

5. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided.

6. Report Routing: Alarm reports shall be archived for future recall.

7. Alarm Messages: In addition to the point's description and the time and date, the user shall be able to print, display or store a custom alarm message to more fully describe the alarm condition or direct operator response.

8. The FACP shall be capable of storing a library of at least 900 events.

9. History Mode:

    a. The system shall be able to store and display at least 900 system events that have occurred in a non-volatile buffer memory. Display of these events shall be accomplished on-site through the use of the front control panel indicators and switches.

10. Field Configurable:

    a. The system shall be fully configurable and expandable without the need for EPROM programmers. All configurations shall be accomplished through downloading of programs from a computer. Reconfiguration shall not require knowledge of any programming languages or require any special training. All programs shall be stored in non-volatile memory. Entry into program mode shall require a special key and a special password entered into the front panel.

D. Analog Device Interface:

1. The Analog Device Interface will be capable of supporting devices as indicated on drawings with 25 percent spare slots for future devices.

2. The analog addressable device interface shall contain its own microprocessor control.

3. The analog addressable device interface shall communicate and provide power to all devices on its loop over a single pair of wires. The fire-alarm system shall function as a Class A system.

4. The analog interface board shall receive analog information from intelligent detectors and shall process this information to determine normal, alarm, or trouble conditions. The analog information may also be used for automatic test and determination of maintenance requirements.

5. Communication with connected devices shall be performed every 5 seconds or less. Average time to detect an alarm shall be less than 10 seconds (longer for alarm verification detectors).

E. Notification Appliance Circuit:

1. The FACP shall provide supervised Class A notification circuits as indicated on drawings with 50 percent spare capacity for future devices. The circuit capacity shall be 2.0 amperes maximum per circuit, maximum of 8.0 amperes from the FACP's power supply. If a short-circuit trouble occurs on one of the circuits it will not affect the operation of the remaining circuits.

F. Amplifiers, Preamplifiers, Tone Generators:

1. Any amplifiers, preamplifiers, tone generators, digitalized voice generators, and other hardware necessary for a complete, operational, textual audible circuit conforming to NFPA 72 shall be housed in a fire alarm control unit, terminal cabinet, or in the fire alarm control panel. The system shall automatically operate and control all building fire alarm speakers except those installed in the stairs and within elevator cabs. The speakers in the stairs and elevator cabs shall operate only when the microphone is used to deliver live messages. Each amplifier shall have two channels; one to broadcast a message and the other for paging.

a. Construction: Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

b. Inputs: Each system shall be equipped with separate inputs from the tone generator, digitalized voice driver and panel mounted microphone. Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier.

c. Tone Generator: The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a slow whoop tone, which shall slowly ascend from low (500 Hertz) to high (1200 Hertz), and shall be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. Each slow whoop cycle shall last approximately 4 seconds. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator cause the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay.

d. Protection Circuits: Each amplifier shall be constantly supervised for any condition which could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate

logging of the condition of the system printer, and other actions for trouble conditions as specified.

G. Function Relays:

1. The FACP shall provide of Form "C" relay contacts, quantity as required, rated at 2 A at 120 VAC. These relays may be programmed to activate on alarm from any initiating zone or any combination of initiating zones, analog devices or addressable modules.

H. Central Processing Unit (CPU):

1. The CPU shall communicate with the operator interface, LCD display, LED display and control other modules in the panel. Removal, disconnection or failure of any control panel shall be detected and reported by the Central Processing Unit.

2. The CPU shall contain and execute all control-by-event programs for specific action to be taken if a fire situation is detected in the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs. The CPU shall also provide a real time clock for time annotation on the display and remote optional printer.

I. Operator Display:

1. The operator display shall provide controls and indicators used by the system operator. The display shall contain, and display as needed, custom alphanumeric message for all intelligent detectors and addressable modules. Such message information shall be stored in programmable non-volatile memory.

2. The display board shall provide an 80-character alphanumeric Liquid Crystal Display (LCD). It shall also 24 LEDs for system indication such as AC POWER; SYSTEM ALARM; SYSTEM TROUBLE; ACKNOWLEDGE; SIGNAL SILENCE, etc.

3. Factory programmable system indications and keys shall be available for unique functions. Keys shall be referred to as "Hot Keys".

4. The Display Interface shall provide a 15-key touch keypad with control capability to command all system functions, and entry of any numeric information. The keypad shall include means to enter a minimum of two different passwords to prevent unauthorized manual control.

5. Ground fault indication shall be displayed on a system and initiating zone basis.

J. Communications Ports:

1. The system shall provide the following interfaces:

a. One port for remote annunciator command center.

b. One port for central station communication.

c. One port for service and field programming.

d. One port for Printer.

K. Mechanical Design:

1. The Fire Alarm Control Panel (FACP) shall be housed in a cabinet designed for mounting recessed or directly to a wall or vertical surface. The back box and door shall be constructed with provisions for electrical conduit connections. The door shall provide a key lock and shall include an opening for viewing.

2. The FACP shall be modular in structure for ease of installation and maintenance.

L. One Person Test Feature: The control unit shall include a special one person test feature, which will allow a single person to test all initiating devices and indicating appliance in a system without returning to the panel to reset the system. A special password shall be required to enter the test mode. The service-technician shall be able to re-select the initiating and indicating circuits that are to be included in the one person test mode. The Walk-Test shall include a special audible indication that a trouble has been detected on an analog device, for the service-technician to check proper system wiring.

M. Provide addressable monitor modules to interface manual FACP to stations and other non-addressable detection components as required. The modules shall be capable of being mounted in a 4 x 4 x 2 1/8 inch junction box.

N. Provide addressable control modules to interface FACP to fire alarm reporting panel, audible and visual devices and other control components as required. The modules shall be capable of being mounted in a 4 x 4 x 2 1/8 inch junction box.

O. Fire-Alarm Initiating Devices:

1. Addressable Devices: All addressable detectors shall:

a. Provide a test means whereby they will simulate an alarm condition and report that condition to the FACP. Such a test may initiated at the detector itself, by activating a magnetic switch, or may be activated remotely on command from the control panel.

b. Provide address-setting means on the detector head using switches. The detectors shall also store an internal identifying code which the FACP shall use to identify the type of detector.

c. Provide dual alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel. Both LEDs may be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.

2. Addressable pull stations shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. Operated stations shall have a positive, visual indication of operation and utilize a key type reset. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inch or larger. Mount stations inside a red, weatherproof

enclosure with a clear polycarbonate hinged front cover where station is indicated on the drawings as NEMA 4, NEMA 4X and hazardous areas including Class I, Division 1 and 2.

3. Analog/Addressable Area Photoelectric Smoke Detectors: Photoelectric Smoke Detectors shall use the photoelectric principle to measure smoke density and shall, on command from the control panel send data to the panel representing the analog level of smoke density. These addressable detectors shall connect with two wires to one of the control addressable input circuits.

4. Analog/Addressable Thermal Detectors: Thermal detectors shall use an electronic sensor to respond to temperatures exceeding 135 degrees F or 190 degrees F as noted on the plans. Sensing elements shall be replaced without removing the detector base. The detector shall, on command from the control panel, send data to the panel representing the analog temperature level. These addressable detectors shall connect with two wires to one of the control addressable input circuits.

5. Each detector shall be provided with a steel mounting plate, and the entire unit shall mount on a double gang electrical box.

6. Analog/Addressable Duct Smoke Detectors:

    a. The detectors shall, on command from the control panel, send data to the panel representing the analog level of smoke intensity.

7. Provide devices suitable for the area classifications as indicated on the Contract Drawings (i.e., NEMA 1, NEMA 4, NEMA 4X, and NEMA 7 (Class I, Division 1 or 2) NEMA 4X, etc).

P. Fire Alarm Indicating Devices:

1. Visual appliances shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. Where multiple visual signals are visible from any location, circuitry shall be incorporated for the synchronization of the flash rate.

    a. UL 1971 Listed for Emergency Devices for Hearing Impaired in all public mode installations.

    b. Strobes shall meet UL 1971 flash rate.

    c. Visual signals shall incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid state circuitry.

    d. The strobe intensity shall be rated per UL 1971.

    e. The strobes shall be available for semi-flush or surface mounting and in conjunction with audible signals as required.

2. Audible Devices: Audible evacuation signals shall be provided meeting the following requirements:

    a. Audible Notification appliance shall be electronic and use solid state components.

b. Each electronic signal shall provide four field selectable alarm tones. The tones shall consist of: slow hoop, continuous, temporal or interrupted.

c. The device shall provide UL dBA measurement at 10 feet shall be a minimum of 85 dBA for separately mounted audible signals.

d. The device shall have provisions for standard reverse polarity type supervision and in/out field wiring using terminals that accept 14 AWG wiring.

e. Combination audiovisual alarm horns shall have a high intensity flashing light and alarm horn as an integral unit. Both audio and visual components shall operate from the 24 volt dc polarized indicating circuits. The horn assembly shall be housed in a rugged, die-cast enclosure, and the electronic light source shall be sealed in silicone and protected by a Lexan lens. The word FIRE shall appear on the lens. Audiovisual alarm devices shall meet the requirements of visual appliances and alarm horns above. Single and/or dual projectors shall be supplied as shown on the plans.

3. Fire Alarm Speakers:

a. Provide fire alarm speakers conforming to UL 464 having a minimum of three tap settings and separate terminations for each in and out connection. Tap settings shall include taps of 1/4, 1/2 and 1 watt. Speakers shall utilize the 1/2 watt tap in the system. Speakers shall have an output rating of 84 dBA at 10 feet as determined by the reverberant room test; data on peak output as determined in an anechoic chamber is not suitable. Speakers shall be capable of installation on standard 4 inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall mounted unit.

b. Provide speaker mounting plates equipped with mounting holes and other opening as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

Q. Power Supply:

1. The power supply for the FACP and fire alarm peripherals shall be integral to the FACP. The power supply shall provide FACP and peripheral power needs.

2. Positive-temperature-coefficient thermistors, circuit breakers, or other over-current protection shall be provided on all power outputs.

3. Input power shall be 120 VAC, 60 Hertz. The power supply shall provide internal batteries and charger. Internal battery capacity shall be sized as required to meet system requirements.

4. The main power supply shall provide a battery charging circuit consisting of a fully automatic standby battery charger, rate compensated, capable of maintaining battery in fully charged state and be capable of recharging batteries to 70 percent of alarm capacity within 12 hours. Provide for normal operation of entire system for 24 hours with power remaining to sound alarms for 5 minutes. For remote stations, provide battery capacity to operate for 60 hours followed by 5 minutes of alarm in accordance with NFPA 72B.

5. Provide charger with the following supervised functions: circuit protection for shorts, open, disconnected or reversed polarity battery connection, supervision or protection of high or low voltage, overcharging and charger failure. Automatic load shedding or battery disconnect on deep discharge to prevent battery damage.

6. Batteries shall be 24 volt, rechargeable, gelled electrolyte, totally sealed, fully charged with al interconnections ready for service, maintenance free, long-life.

R. Wiring within Cabinets, Enclosures, Boxes, Junction Boxes, and Fittings:

1. Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet.

2. Conductors which are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box shall be connected to terminal blocks.

3. Mark each terminal in accordance with the wiring diagrams of the system.

4. Make connections with approved pressure type terminal blocks, which are securely mounted.

5. The use of wire nuts or similar devices shall be prohibited.

S. Terminal Cabinets:

1. Provide a terminal cabinet at the base of any circuit riser, and where indicated on the drawings.

2. Terminal size shall be appropriate for the size of the wiring to be connected.

3. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the terminal cabinet.

4. Minimum size is 8 inch high by 8 inch .

T. Alarm Wiring:

1. Signaling line circuits and initiating device circuit field wiring shall be copper, 18 AWG size conductors at a minimum.

2. Notification appliance circuit conductors, that contain audible alarm devices, shall be solid copper 14 AWG size conductors at a minimum.

3. Where a voice evacuation system is specified, speaker circuits shall be copper 16 AWG size conductors at a minimum.

4. Wire size shall be sufficient to prevent voltage drop problems.

5. Power wiring, operating at 120 VAC minimum shall be 12 AWG solid copper having similar insulation.

6. Provide all wiring in rigid metal conduit

U. Conductor Terminations:

1. Labeling of conductors at terminal blocks in terminal cabinets, FACP, and remote fire alarm control units shall be provided at each conductor connection.

2. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation.

3. Each terminal cabinet, FACP, and fire alarm control unit shall contain a laminated drawing which indicates each conductor, its label, circuit, and terminal.

4. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals.

5. Maintain existing color code scheme where connecting to existing equipment.

V. Wiring to Station Fire Alarm Circuit:

1. Wiring from the master fire alarm box to the state telegraphic fire alarm circuit shall be a two-conductor 10 AWG type UF cable in conduit.

W. Remote Annunciator Command Center:

1. The remote Annunciator Command Center (ACC) shall be an 80 (4 x 20) character back-lit LCD type capable of displaying up to 3200 point messages. The remote annunciator shall have the capability of driving up to 576 LEDs for future graphic notification. They shall be sixteen switch inputs that can be used for various system functions; lamp test, trouble silence, general alarm, scroll, system reset, network reset, etc. All fire-alarm controls shall be operational from the Annunciator Command Center.

2. The ACC shall have non-volatile memory. Annunciators which rely on the FACP for memory will not be accepted.

3. The ACC shall be surface mounted with switches located with a locked panel, and easily visible through a glass or plastic viewing plate. Panel door shall have a keyed lock identical to the lock on the fire alarm control panel (FACP).

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install fire alarm system as indicated on the drawings, in accordance with the manufacturer's diagrams and printed instructions, except where otherwise indicated.

1. Wiring: Wiring for systems shall be installed in conduit. Ruse existing fire alarm conduit system where applicable; otherwise, provide conduit as specified in Section 26 05 33.

2. Station loops shall be arranged to permit disconnecting and bypassing the system at the base of each riser. External wiring between the control panel and the stations and horns/lights shall connect to terminal strips in accessible locked cabinets. Connections to the terminal strips shall be made with terminal spade lugs or with approved type terminal blocks. Terminal cabinets shall be installed at each point where a station circuit riser

originates or any point along a circuit where a tap is made. The conductors for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. The sum of the cross-sectional areas of individual conductors shall not exceed 40 percent of the interior cross-sectional area of the conduit. Gutter space to accommodate all necessary wiring shall be provided.

3. Panels: Panel enclosures shall comply with the requirements of UL 864. Enclosures having doors over 8 inch in height shall be provided with a three-point catch and lock; all other doors shall contain a cabinet type cylinder lock. Inserts shall be blind fastened so that no screws show on the panel front.

4. Detectors: Detectors shall be installed in accordance with manufacturer's printed instructions.

5. Provide complete wiring and conduit between all equipment. Devices shall be mounted upon UL listed boxes. Wiring splices and transposing or changing of colors will not be permitted.

6. Junction boxes shall be painted red and labeled as “Fire Alarm System” with decal or approved markings.

7. Firm Alarm control systems and equipment shall be connected to separate dedicated branch circuits, sized as required for proper service. Circuits shall be labeled “FIRE ALARM.”

8. Review the design drawings and perform a walk-through of all areas with the AHJ.

3.02 PERMITS AND CERTIFICATIONS:

A. Obtain required local permits.

1. Provide UL certification of the installation.

3.03 FIELD TESTING:

A. Notify the AHJ and the Owner 30 days before the performance and acceptance tests are to be conducted. The tests shall be performed in the presence of the Owner or his authorized representative. Furnish instruments and personnel required for the tests. Tests shall be conducted for the following:

1. Verify that the system is free of grounds or open circuits. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. The FACP shall indicate when a ground or open circuit exists.

2. Alarm initiating devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.

3. Verify that all strobes, audible devices, pull stations, transmitters, automatic detectors and supervisory devices are functioning as specified.

a. Strobes shall deliver the correct foot-candle. Audible devices shall delivery the correct sound pressure levels decibels of the specified device.

b. Stations shall close the circuits specified and deliver specified alarm codes. Verify central station receives alarm.

c. Automatic detectors shall actuate the specified zones when the appropriate fire or smoke conditions are generated. The detectors shall be exposed to actual smoke used to simulate this test on each and every smoke detector as located in the building; no other test will be accepted.

d. Panels and supervisory devices shall display and control functions as specified. Loss of AC system power shall also be tested.

e. Close each sprinkler system valve and verify proper supervisory alarm.

f. Verify activation of all water flow switches.

B. System tests to be performed under the supervision of a qualified representative and the AHJ.

C. Perform all tests to verify the correction of defects found in the initial testing. If testing identifies system modifications are required to accomplish the required operation, perform work at no additional cost to the Owner and retest the system.

D. Furnish training as follows:

1. Training in the receipt, handling and acknowledgment of alarms.

2. Training in the system operation including manual control of output functions from the system control panel.

3. Training in the testing of the system.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 28 31 00

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SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide grading as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Rough grading.

2. Finish grading.

3. Stockpiling of topsoil and subsoil.

4. Disposal of unsuitable and excess materials.

1.02 DEFINITIONS:

A. Unsuitable Material: Defined in Section 31 23 00.

B. Foundation Influence Zone (under foundations, pavements, or sidewalks): Area below base bounded by 1/2H:1V slope extending outward from 1 feet beyond outer edges.

C. Utility Influence Zone (around piping or ducts): Area below with limits bounded by perpendicular line, 6 inches below pipe or duct with a 1/2H:1V slope extending outward from that line, 1 feet beyond the edge of pipe or duct.

1.03 SUBMITTALS:

A. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

1.05 SITE CONDITIONS:

A. Existing Conditions:

1. Refer to Geotechnical and Soils Report

2. Existing facilities, structures, and utilities are shown in accordance with available surveys and records. The indicated locations of underground utilities and structures are approximate. Other utilities may exist which are not indicated.

3. Verify location of existing underground utilities and structures by contacting utility owners. Go to “Call Before You Dig” to receive state-specific information. Access this information by dialing 811 or going to http://call811.com/state-specific.aspx.

B. Geotechnical Report, Design Basis Report Appendix A: The report is for information only. Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify survey benchmarks and intended elevations for the work are as indicated.

B. Verify temporary erosion and sediment control measures are installed before commencing with any other work at the site.

C. Immediately notify the Engineer if suspected hazardous materials are encountered and cease operations in that area. Refer to Supplemental Conditions for Hazardous Environmental Condition and Environmental Assessment reports.

D. Identify areas loosened by frost action, softened by flooding or weather, or containing unsuitable material.

3.02 PREPARATION:

A. Remove material loosened by frost action, softened by flooding or weather, or containing unsuitable material. Replace and compact to same requirements as for specified fill in Section 31 23 00.

B. Identify required lines, levels, grades, and datum.

C. Stake and flag locations of known utilities.

D. Locate, identify, and protect from damage all above- and below-ground utilities to remain.

E. Notify utility owner prior to removal or relocation of utility.

F. When necessary to excavate through roots of trees or vegetation to remain – perform work by hand and cut roots with sharp axe.

3.03 ROUGH GRADING:

A. Topsoil removal and stockpiling:

1. Strip topsoil from areas that are to be excavated, landscaped, or graded.

2. Separate organic matter (e.g. root zones) from topsoil. Dispose of organic material off site.

3. Do not strip topsoil while wet.

4. Stockpile excavated topsoil on site. Do not mix topsoil with foreign materials.

B. Subsoil removal and stockpiling:

1. Remove subsoil from areas that are to be excavated, landscaped, or graded.

2. Do not remove wet subsoil unless it is subsequently processed to obtain optimum moisture content.

3. Stockpile suitable subsoil on-site.

C. Provide for free drainage of construction site.

D. Benching Slopes: Horizontally bench existing slopes greater than 3H:1V to key fill material to slope for firm bearing.

E. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill in Section 31 23 00.

F. Disc level surfaces.

G. Rough grade site to achieve lines and grades indicated with allowances for imported fill thicknesses.

H. Provide positive drainage away from buildings and structures by sloping minimum of 3 inches over 10 feet.

3.04 FINISH GRADING:

A. Before finish grading:

1. Verify subgrade is contoured and compacted.

2. Verify backfill has been inspected.

B. Fine grade to eliminate uneven areas and depressions. Follow profiles and contours of subgrade and bring to finish grade as indicated.

C. Final grading levels include 8-inch gravel layer of number 57 stone.

3.05 STOCKPILING:

A. Location: As indicated or directed. Do not locate stockpiles over existing or new utilities unless directed.

B. Height: 8 feet maximum.

C. Slope: 2H:1V, maximum

D. Drainage: Grade to prevent standing water.

E. Provide erosion and sediment control around downhill-side of stockpile perimeter.

F. Immediately stabilize dormant stockpiles within 7 days. Stockpiles and portions of stockpiles that will not be actively used for at least 30 days shall be considered dormant.

3.06 EXCESS MATERIAL:

A. Excess grading material, suitable for backfilling or site grading, that is not necessary to complete the work at the project site belongs to the Owner. If the owner does not choose to use the material, it shall be delivered to an off-site designated location within a 10 mile radius from project site at the Contractor's expense. If the designated location exceeds 10 miles from the project site, the client will be liable for additional costs.

B. Dispose off site, unsuitable materials and excess materials not received by Owner at Contractor's cost.

3.07 TOLERANCES:

A. Subgrade:

1. Elevation: 1 inch, from required elevation.

2. Grade: 1 inch per 10 feet.

B. Finish Grade:

1. Elevation: 1/2 inch, from required elevation.

3.08 FIELD QUALITY CONTROL:

A. See Section 31 23 00 for compaction and testing requirements.

3.09 CLEANING:

A. Remove unused stockpiles, grade area to prevent standing water, protect from erosion, and stabilize.

B. Leave site clean and raked, ready to receive landscaping.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

B. Submit existing utility location information as part of record drawings. Include ticket numbers and original information from utility owners.

END OF SECTION 31 22 00

SECTION 31 2210 – BUILDING EARTHWORK

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

Section Includes:

1. This section applies to the mixing-dosing building, walkways, parking areas, and truck-parking canopy in the spent deicing area only.
2. Preparing subgrades for slabs-on-grade.
3. Excavating and backfilling for buildings and structures.
4. Drainage course for concrete slabs-on-grade.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 PREINSTALLATION MEETINGS

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

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:

a. Personnel and equipment needed to make progress and avoid delays.
b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to ASTM D698.

1.6 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

C. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

H. Sand: ASTM C33/C33M; fine aggregate.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, flowable concrete material produced from the following:

1. Portland Cement: ASTM C150/C150M, Type I.
2. Fly Ash: ASTM C618, Class C or F.
3. Normal-Weight Aggregate: ASTM C33/C33M, 3/8-inch nominal maximum aggregate size.
4. Foaming Agent: ASTM C869/C869M.
5. Water: ASTM C94/C94M.
6. Air-Entraining Admixture: ASTM C260/C260M.

B. Produce low-density, controlled low-strength material with the following physical properties:

1. As-Cast Unit Weight: 30 to 36 lb/cu. ft. at point of placement, when tested according to ASTM C138/C138M.
2. Compressive Strength: 80 psi, when tested according to ASTM C495/C495M.

2.3 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in

a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.

3.12 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.13 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 31 2210

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide excavation and fill for the Lift Station, Prestressed Concrete Water Storage Tanks, and Precast Reinforced Concrete Vaults as indicated and in compliance with Contract Documents. Refer to Section 31 22 10, Building Earthwork for the excavation and fill related to the Mixing-Dosing Building, walkways, driveways, parking ways, and Truck Parking Canopy in the spent deicing fluid area only.

B. Section includes:

1. Excavation and fill for: Foundations, structures, and pavement; site drainage, structures, and features.

2. Below-grade utilities within building footprints. (Refer to Section 31 23 33 for trenching and backfill.)

3. Embankments.

4. Dewatering excavations.

5. Controlled fill using materials from imported and on-site sources.

6. Soil and aggregate materials.

7. Compaction and testing.

1.02 REFERENCES:

A. American Association of State and Highway Transportation Officials (AASHTO):

1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

B. ASTM International (ASTM):

1. C33: Specification for Concrete Aggregates.

2. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

3. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.

4. D422: Test Method for Particle-Size Analysis of Soils.

5. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3).

6. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

7. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3).

8. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

9. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

10. D2940/D2940M: Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways or Airports.

11. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

12. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

1.03 CLASSIFICATION OF EXCAVATION:

A. Excavation is part of the lump sum contract price for the spent deicing facility project. Excavation is not classified, except where rock excavation is authorized outside specified or indicated limits of excavation. The contractor shall use the Geotechnical and Soils report as basis for classification of excavations.

1.04 DEFINITIONS

A. Percent Compaction or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.

B. Field Dry Density or Field Density: In-place density as determined by ASTM D1556 (Sand Cone Method), ASTM D2167 (Rubber Balloon Method), or ASTM D6938 (Nuclear Method).

C. Maximum Dry Density: Laboratory density as determined by ASTM D698 (Standard Proctor) or ASTM D1557 (Modified Proctor) and occurring at the optimum moisture content of the material being tested.

D. Proof Roll: Single pass of a drum or rubber tire roller, having a gross load between 25 to 50 tons. Rubber tire rollers shall have tires capable of operating at inflation pressures ranging from 90 to 150 psi. Weight and contact pressure shall be as recommended by geotechnical engineer for the material being tested.

1.05 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Temporary excavation and shoring drawings for worker protection in accordance with the General Conditions.

2. Geotextile:

   a. At least two weeks prior to shipment, submit manufacturer's certificate of compliance and physical property data sheet indicating that requirements for materials and manufacture are in conformance as specified.

   b. For informational purposes only, submit manufacturer's printed installation instructions.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Sustainability Standards Certifications.

C. Provide verification from testing laboratory that materials contain less than 1 percent asbestos by weight or volume. Submit asbestos report from testing laboratory to Engineer for acceptance.

D. Testing will be provided by the Owner as specified. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.

E. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. Geotextile Fabric:

1. Provide rolls wrapped with protective covering to protect from mud, dirt, dust, and debris. Label each roll with number or symbol to identify production run.

2. Protect from sunlight during transportation and storage. Do not leave exposed to sunlight for more than two weeks during installation operations.

1.08 SITE CONDITIONS:

A. Existing Conditions:

1. Logs of borings: Logs of borings are included in the bid documents and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

2.01 FILL MATERIALS:

A. Suitable Material: Material from on-site excavation and/or permitted off-site sources that meets all of the specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material is suitable.

B. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

1. Organic clay, organic silt, or peat; as defined in ASTM D2487.

2. Vegetation, wood, roots, leaves, and organic, degradable material.

3. Stones or rock fragments over 6 inches in any dimension.

4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.

5. Ice, snow, frost, or frozen soil particles.

C. General Fill: Suitable, unclassified material.

D. Structural Fill: Suitable material that is classified by the Unified Soil Classification System (USCS) in accordance with ASTM D2487 as GW, GP, GM, GC, SW, SP, SM, SC, CL, ML, CH, MH. Verify that the largest particles in the fill are no greater in dimension than one-half the thickness of the compacted lift thickness.

E. Embankment Fill: Structural Fill; Classified in accordance with ASTM D2487 classification as CL.

F. Concrete Fill: Minimum compressive strength, 3,000 psi.

G. Granular Fill:

1. Conform to ASTM D-2487 Group GW.

2. Densely Graded: Bank-Run Gravel with the following properties.

a. Natural deposit, unprocessed except when needed to remove deleterious materials and stones larger than maximum size allowed.

b. Soil particles: ASTM C33, physical property requirements.

c. Material source: Submit to Engineer for acceptance.

d. Gradation: Table 31 23 00-1.

Table 31 23 00-1	
Sieve Designation (Square Mesh)	Percentage Passing (By Weight)
6 inches	100
2 inches	80-100
No. 4	20-65
No. 50	10-25
No. 200	0-12

3. Open Graded: ASTM C33, coarse aggregate, No. 57.

4. Open Graded: Crushed Stone: ASTM C33, Coarse Aggregate, No. 67. Soil particles shall conform to the physical property requirements of ASTM C33.

H. Sand: Natural sand. Comply with ASTM D-2487 Group SW.

I. Select Borrow:

1. Well-graded, coarse-grained soil; classified in accordance with ASTM D2487 as GW, GW-GM, GW-GC, SW, SW-SM, or SW-SC.

2. Soil particles: ASTM C33, physical property requirements.

3. Gradation: Table 31 23 00-2.

Table 31 23 00-2	
Sieve Designation (Square Mesh)	Percentage Passing (By Weight)
3 inches	100
1-1/2 inches	70-100
3/4 inches	50-85
No. 4	30-60
No. 50	10-25
No. 200	0-5

2.02 EQUIPMENT:

A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that dewatering support systems are in place before commencing with excavation.

B. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.

2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.

C. Verify that fill materials submittals have been accepted by Engineer before commencing with work requiring the use of these materials.

D. Verify that erosion and sediment control measures are in place and functioning properly.

E. Immediately notify the Engineer if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.

F. Test Pits:

1. Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface restored and maintained in a manner satisfactory to the Engineer.

2. Excavate test pits to field verify the locations of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

3.02 PREPARATION:

A. Underpin adjacent structures that could be damaged by excavation work.

B. Cut pavement with saw or pneumatic tools to prevent damage to remaining pavement. Dispose of large pieces of demolished pavement before proceeding with excavation.

C. Remove subsurface structures and related obstructions as indicated.

D. Remove boulders within excavation limits.

3.03 PROTECTION OF IN-PLACE CONDITIONS:

A. Support and protect from damage – existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.

B. Excavation Near Existing Structures:

1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.

2. Excavate test pits near, or at intersection with, existing utilities or underground structures to determine the exact location of existing features.

C. Excavation Near Private Property:

1. Enclose uncut tree trunks adjacent to work in wooden boxes of such height necessary to protect tree from injury due to piled material, equipment, or operations. Operate excavating machinery and cranes so as to prevent injury to overhanging branches and limbs.

2. Protect cultivated hedges, shrubs, and plants which would otherwise be damaged by the work.

3. Where protection of vegetation is not possible, dig up, temporarily transplant, and maintain. After active construction operations in the area have ceased, transplant vegetation to the original positions and provide water and nursery care until growth is re--established.

4. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces. Provide protection on pavement or tracks if construction traffic is unavoidable.

3.04 RESTORATION:

A. Restore private property and structures promptly. Begin restoration work within 24 hours of when damage occurred.

B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.

C. Damaged Trees To Remain: Cut all damaged branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint. Replace damaged trees which subsequently die or continue to show lack of growth due to damage.

D. Cultivated Vegetation: Includes, but is not limited to: hedges, shrubs, and plants. Vegetation that is damaged shall be replaced with equal kind and of at least the quality before work began.

3.05 EXCAVATION:

A. Excavate to accommodate new structures and construction operations.

B. Excavate to lines and grades necessary to provide finish grades.

C. Excavations that are not shored and deeper than 4 feet shall have banks laid back to a minimum stable slope matching the angle of repose of the excavated material.

D. Workers shall have an adequate means of exit from excavations that are 4 feet or greater in depth. The means of exit shall not require more than 25 feet of lateral travel.

E. Establish limits of excavation to allow adequate working space for installing forms and for safety of personnel.

F. Carry out program of excavation, dewatering, and excavation support systems to eliminate possibility of undermining or disturbing foundations of existing structures or the work.

G. Provide dewatering system in accordance with Section 31 23 19.

H. Preserve material below and beyond the lines of excavations.

I. Locate stockpiled excavated material at least 3 feet (90 cm) from edge of excavations to prevent cave-ins or bank slides.

J. Excavate for depressed mat foundations so that adjacent sections of foundation mat will rest on undisturbed ground.

3.06 SUBGRADE PREPARATION:

A. The exposed surface shall be examined by an engineering geologist or soils engineer to determine that the proper bearing material has been exposed.

B. Materials which are determined to be unsuitable by visual inspection shall be over-excavated below the foundation subgrade and backfilled with structural fill.

C. Backfill with compacted open-graded granular fill or crushed stone wrapped with nonwoven geotextile fabric. In no case shall the aggregate be placed directly on the exposed subgrade prior to placing the geotextile fabric.

D. Compact subgrade and proof roll to identify soft spots or other deficiencies prior to filling operations or placing foundations. Correct deficiencies as specified for AUTHORIZED OVER-EXCAVATION and repeat proof roll procedure until successful.

E. When subgrade is below controlled fill, scarify subgrade to bond with subsequent material lifts.

F. Proof roll foundation subgrade prior to filling operation or placing foundation concrete. Continue until successful proof test is attained.

3.07 AUTHORIZED OVER-EXCAVATION:

A. If proof roll test fails then remove unsuitable material plus an additional 6 inches, and backfill with structural fill.

3.08 UNAUTHORIZED EXCAVATION:

A. Contractor is responsible for backfilling unauthorized excavations with structural fill.

3.09 FILL:

A. Fill to lines and grades necessary to provide finish grades.

B. Use a placement method that does not disturb or damage other work or existing features.

C. Maintain fill materials within 3 percent of optimum moisture, to attain required compaction density.

D. Place and compact material in equal continuous layers.

E. General fill may be used in open areas, over lot fill, and areas which are not load bearing.

F. Use structural fill beneath and adjacent to buildings and structures, and beneath pavements.

G. Use concrete fill where footing bearing surfaces are over-excavated or footing is otherwise not bearing on undisturbed soil.

H. Maximum compacted depth is 6 inches for aggregate materials and 8 inches for soil materials, unless noted otherwise.

I. Do not backfill against or on hydraulic structures until testing is completed. See Section 03 05 10 for leakage testing requirements of concrete containment structures. Conduct hydraulic testing as soon as practicable after structures are constructed and other necessary work has been done. Start backfilling promptly after completion of tests.

J. Deposit material evenly around structure to avoid unequal soil pressure.

K. Do not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking, or other damage.

3.10 COMPACTION:

A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified, or if not specified - at a level slightly lower than optimum.

B. Compaction Density: Provide densities in Table 31 23 00-3. The values listed are minimum percentages, unless noted otherwise.

Table 31 23 00-3	
Area	**Percentage of Maximum Dry Density as defined by ASTM D1557 (Modified Proctor)**
Scarified subgrades	90
Under pavement, slabs	95
Under structures or within 25 feet (7.5 m) of structures	95
Stormwater Management (SWM) basin embankment	98
Under exterior concrete slab and sidewalks	90
Open or grassed areas	85
Topsoil	85

3.11 BACKFILLING AGAINST STRUCTURES:

A. Backfill shall not be placed against foundation walls until all interior floors have been placed and the concrete has attained design strength. This includes the floor level at grade or the next level above grade if no floor is within 2 feet of finished grade.

B. Backfill shall not be placed against cantilever walls until the concrete has attained design strength.

3.12 EMBANKMENT FILL AND COMPACTION:

A. Begin filling in lowest section of work area. Grade surface of fill approximately horizontal but provide with sufficient longitudinal and transverse slope to allow for runoff of surface water from every point.

B. Install temporary dewatering sumps in low areas during filling operation where excessive amounts of rain runoff collect.

C. Reduce moisture content of fill material, if necessary, in source area by aerating it over during warm and dry atmospheric conditions. A large disc harrow with two to three foot diameter disks may be required for working soil in a drying operation.

D. Compact uniformly throughout. Keep fill surfaces sufficiently smooth and free from humps and hollows to allow for proper and uniform compaction. Do not permit hauling equipment to follow a single track on the same layer but direct equipment to spread out to prevent over compaction in localized areas. Take care in obtaining thorough compaction at edges of fill.

E. Slightly slope surface of fill to ensure drainage during periods of wet weather. Do not place fill while rain is falling or after a rain-storm until the Engineer considers conditions satisfactory. During such periods and upon suspension of filling operations for periods in excess of 12 hours, roll smooth the surface of fill using a smooth wheel static roller to prevent excessive absorption of rainfall and surface moisture. Prior to resuming compaction operations, remove muddy material off surface to expose firm, compacted material, as determined by the Engineer.

F. When fill is placed against an earlier fill or against in-situ material under and around structures, including around piping beneath structures or embankments, slope junction between two sections of fill at 1.5 to 1 (horizontal to vertical). Bench edge of existing fill 24 inches to form a serrated edge of compact stable material against which to place the new fill. Ensure that rolling extends over junction between fills.

G. Clean debris, remove loose material, and proof roll previously placed fill which has had time to become desiccated or littered with debris.

H. After spreading each loose lift to the required thickness and adjusting its moisture content, roll with sufficient number of passes to obtain the required compaction. One pass is defined as the required number of successive trips which by means of sufficient overlap will insure complete coverage and uniform compaction of an entire lift. Do not make additional passes until previous pass has been completed.

I. Fill surface shall be firm and hard when rolled. Reduce moisture content when fill material sinks and weaves under rollers and equipment. Spread out rolling operations over the maximum practicable area to minimize condition of sinking and weaving. Suspend fill operations on portions of embankment where inundations produce surface cracks.

J. Remove material which fails testing requirements and replace work.

3.13 GEOTEXTILE:

A. Install geotextile fabric in accordance with manufacturer's printed instructions.

B. Place geotextile fabric on the foundation subgrade prior to placing aggregate material.

C. Overlap geotextile fabric 18 inches minimum for unsown lap joint. Overlap fabric 6 inches at seam for sewn joint.

D. Do not permit traffic or construction equipment to travel directly on geotextile fabric.

E. Place geotextile fabric in relatively smooth condition to prevent tearing or puncturing. Lay geotextile fabric loosely but without wrinkles or creases so that placement of the backfill materials will not stretch or tear geotextile fabric. Leave sufficient slack in geotextile fabric around irregularities to allow for readjustments.

F. Patch all tears in geotextile fabric by placing additional section of geotextile fabric over tear with a minimum of 3 feet overlay.

G. Extend the geotextile fabric and wrap around aggregate material along the perimeter of the foundation.

3.14 FIELD QUALITY CONTROL:

A. See conditions of contract for general requirements.

B. Perform inspection at least once daily to confirm lift thickness and compaction effort for entire fill area.

C. Perform particle size distribution and gradation analyses using ASTM D422 and following standard practices in ASTM D421. Perform 1 test for every source and submit results to

Engineer for acceptance. Repeat the moisture density test for every 5,000 cubic yard of material used.

D. Perform field density testing in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

E. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with ASTM D1557 (Modified Proctor).

F. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Minimum of one test per 5,000 cubic yard of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

G. Location of field density tests shall be as recommended by the Engineer.

H. In the event compacted material does not meet specified in-place density, re-compact material and re-test area until specified results are obtained.

I. Frequency of field density tests:

Table 31 23 00-5	
Area	**Frequency**
Roadways	1 per lift for every 200 linear feet of roadway
Paved Areas	1 per lift for every 3,500 square feet of pavement
Open Areas	1 per lift for each 25,000 square of open area
Isolated Footing Perimeter	1 per alternate lift for each 25 linear feet
Footing and Wall Backfill	1 per alternate lift for each 50 linear feet (both sides of wall)
Under Structures	1 per lift for every 1,000 square feet of structure
Around Structures	1 per lift for every 1,500 square feet of structure
Embankment Fills	1 per lift for every 10,000 square feet of embankment
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

3.15 ADJUSTING:

A. Shrinkage:

1. Build embankments or backfill to a height above finished grade which will, in the opinion of the Engineer, allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.

2. Supply specified materials to build up low places when embankment or backfill settles below the finished grade at any time before substantial completion.

3.16 TOLERANCES:

A. Construct finished surfaces to plus or minus 1 inch of the elevations indicated.

B. Grade areas of cut and fill to plus or minus 0.20 foot of the grades indicated.

C. Complete embankment edges to plus or minus 6 inches of the slope lines indicated.

D. Provide the Engineer with adequate survey information to verify compliance with above tolerances.

3.17 PROTECTION:

A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.18 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 31 23 00

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SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide dewatering as required by construction methods and site conditions and in compliance with Contract Documents.

B. Design, furnish, operate, maintain, and remove temporary dewatering systems to control groundwater and surface water to maintain stable, undisturbed subgrades, and permit work to be performed under dry and stable conditions. Work to be done as part of dewatering includes, but is not limited to:

1. Lower the groundwater level.

2. Lower hydrostatic pressure.

3. Prevent surface water from entering the excavation during construction.

4. Implement erosion control measures for disposing of discharge water.

5. Provide groundwater recharging systems as specified and as indicated.

6. Provide and monitor observation wells and geotechnical instrumentation as specified and indicated.

C. Groundwater within the excavation area shall be lowered to at least 2 feet below the lowest excavation levels as specified and as indicated.

D. Common dewatering methods include, but are not limited to, sump pumping, deep wells, well points, vacuum well points or combinations thereof.

E. Common groundwater recharge methods include, but are not limited to, deep wells, large sumps or combination thereof.

F. The Contractor shall obtain the required permits for discharge from the Contractor's dewatering systems in accordance with 40 CFR Part 122. The discharge location shall be in accordance with permit requirements.

1.02 REFERENCES:

A. Code of Federal Regulations, Title 40 – Protection of Environment (CFR):

1. 40 CFR Part 122: EPA Administered Permit Programs: The National Pollutant Discharge Elimination System.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Qualification of the Contractor's dewatering specialist's or firm's qualifications a minimum of 4 weeks prior to dewatering work. The submittal shall include, but not be limited to:

    a. Qualifications of specialist's or firm's Registered Professional Engineer.

    b. Qualifications of specialist's or firm's field representative who will oversee the installation, operation and maintenance of the dewatering system.

2. Submit a dewatering plan, and, if applicable, a groundwater recharge plan at least 2 weeks prior to start of dewatering work. Do not submit design calculations. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:

    a. Dewatering plan and details stamped and signed by a Registered Professional Engineer registered in the state where the project resides.

    b. A list of equipment including, but not limited to, pumps, prime movers, and standby equipment.

    c. Detailed description of dewatering, maintenance, and system removal procedures.

    d. Monitoring plan and details, including, but not limited to, number and locations of observation wells (minimum of two), and geotechnical instruments such as settlement markers (reference points on structures; minimum of two per structure) and piezometers (minimum of two), and frequency of reading the monitoring devices.

    e. Erosion and sedimentation control measures, and methods for disposal of pumped water.

    f. List of all applicable laws, regulations, rules, and codes to which dewatering design conforms.

    g. List of assumptions mode for design of dewatering and for groundwater recharge systems, including but not limited to groundwater levels, soil profile, permeabilities, and duration of pumping and or recharge.

3. Measurement records consisting of observation well groundwater records and the geotechnical instrumentation readings within one day of monitoring.

4. A modified dewatering plan within 24 hours, if open pumping from sumps and ditches results in boils, loss of fines or softening of the ground.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Employ the services of a dewatering specialist or firm having the following qualifications:

1. Have completed at least 5 successful dewatering projects of equal size and complexity and with equal systems within the last 5 years.

2. Retain the services of a Registered Professional Engineer (in the state where the project is located) having a minimum of 5 years experience in the design of well points, deep wells, recharge systems, or equal systems.

3. Retain the services of a field representative having a minimum of 5 years experience in installation of well points, deep wells, recharge systems, or equal systems.

C. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify the Engineer, stabilize the subgrade, and modify system to perform as specified.

D. Notify the Engineer immediately if settlement or movement is detected on structures. If the settlement or movement is deemed by the Engineer to be related to the dewatering, take actions to protect the adjacent structures and submit a modified dewatering plan to the Engineer within 24 hours. Implement the modified plan and repair damage incurred to adjacent structures.

E. Immediately notify the Engineer if oil or other hazardous materials are encountered after dewatering begins.

1.05 HYDRAULIC UPLIFT OF STRUCTURES:

A. The Contractor shall be responsible for the protection of all structures against hydraulic uplift until such structures have been accepted finally by the Owner.

B. In this regard, the Contractor is advised that all tanks when completed are designed to resist hydraulic uplift from groundwater up to the elevation indicated on the structural drawings when the structure is completed. The concrete slab bottoms shall be placed in the dry, with the use of wellpoints or other dewatering means to keep the water elevation sufficiently low to carry on the work.

C. Buildings with basements are designed to resist hydraulic uplift from groundwater up to the elevation indicated on the structural drawings against the weight of the completed structure, including all masonry, structural steel frames and cladding.

1.06 PRECAUTIONS AGAINST HYDROSTATIC UPLIFT DURING CONSTRUCTION:

A. The Contractor shall maintain a low groundwater elevation in the vicinity of the structures until they are complete. In case of extremely high water during construction of the structures, it may be necessary to flood the structures to maintain stable conditions.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

1.08 SITE CONDITIONS:

A. Subsurface Conditions: Refer to geotechnical and soils report.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide settlement markers, piezometers and other geotechnical instruments in accordance with the submitted dewatering plan or as specified.

B. Provide casings, well screens, piping, fittings, pumps, power and other items required for dewatering system.

C. Provide sand and gravel filter around the well screen. Wrapping geotextile fabric directly around the well screen shall not be allowed.

D. When deep wells, well points, or vacuum well points are used, provide pumping units capable of maintaining high vacuum and handling large volumes of air and water at the same time.

E. Provide auxiliary dewatering equipment in the event of breakdown. Equipment shall consist of pumps and hoses and be stored on site. Provide at least 1 pump for every 5 pumps used.

F. Provide and maintain erosion and sedimentation control devices as indicated or specified and in accordance with the dewatering plan.

G. Provide temporary pipes, hoses, flumes, or channels for the transport of discharge water to the discharge location.

H. Provide cement grout having a water cement ratio of 1 to 1 by volume.

PART 3 – EXECUTION

3.01 INSTALLATION:

A. Execution of earth excavation, installing earth retention systems, and dewatering shall not commence until the related submittals have been reviewed by the Engineer with all Engineer's comments satisfactorily addressed and the geotechnical instrumentation has been installed.

B. Provide and maintain dewatering system in accordance with the dewatering plan.

C. Carry out dewatering program in such a manner as to prevent undermining or disturbing foundations of existing structures or of work ongoing or previously completed.

D. Do not excavate until the dewatering system is operational.

E. Unless otherwise specified, continue dewatering uninterrupted until all structures, pipes, and appurtenances below groundwater level have been completed such that they will not be floated or otherwise damaged by an increase in groundwater elevation.

F. Discontinue open pumping from sumps and ditches when such pumping results in boils, loss of fines, softening of the ground, or instability of the slopes. Modify dewatering plan and submit revised plan to the Engineer for acceptance.

G. Where subgrade materials are disturbed or become unstable due to dewatering operations, remove and replace the materials in accordance with Section 31 23 00.

H. Dewatering Discharge:

1. Install and monitor recharge systems in accordance with the submitted dewatering plan.

2. Install sand and gravel filters in conjunction with well points and deep wells to prevent the migration of fines from the existing soil during the dewatering operation.

3. Transport pumped or drained water to discharge location without interference to other work, damage to pavement, other surfaces, or property.

4. Provide separately controllable pumping lines.

5. The Engineer reserves the right to sample discharge water at any time.

6. Immediately notify the Engineer if suspected contaminated groundwater is encountered. Do not pump water found to be contaminated with oil or other hazardous material to the discharge locations.

I. Monitoring Devices and Records:

1. Install, maintain, monitor and take readings from the observation wells and geotechnical instruments in accordance with the dewatering plan.

2. Install settlement markers on structures within the zone of influence for dewatering a distance equal to twice the depth of the excavation, from the closest edge of the excavation. Conduct and report settlement surveys to 1/8-inch.

3. For large rectangular, square or circular mass excavations the zone of influence shall be defined by the actual cone of watering influence corresponding to a 10 percent increase in effective vertical stress.

J. Install and maintain erosion/sedimentation control devices at the point of discharge as indicated or specified and in accordance with the dewatering plan.

K. Removal:

1. Do not remove dewatering system without written acceptance from the Engineer.

2. Backfill and compact sumps or ditches with screened gravel or crushed stone wrapped with geotextile fabric in accordance with Section 31 23 00.

3. All dewatering wells shall be abandoned upon completion of the work, and completely backfilled with cement grout.

3.02 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 31 23 19

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SECTION 31 23 33

TRENCHING AND BACKFILL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide trenching and backfill as indicated and in compliance with Contract Documents.

B. Section includes:

1. Trench excavation width and safety.

2. Backfill materials and placement.

3. Utility identification using marking tape and trace wire

4. Soil and aggregate materials.

5. Compaction and testing.

1.02 REFERENCES:

A. American Association of State and Highway Transportation Officials (AASHTO) Publications:

1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

B. American Public Works Association (APWA):

1. Public Works Management Practices Manual; latest edition.

C. ASTM International (ASTM):

1. C33: Specification for Concrete Aggregates.

2. C150: Standard Specification for Portland Cement.

3. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

4. D75: Standard Practice for Sampling Aggregates.

7. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.

8. D422: Test Method for Particle-Size Analysis of Soils.

9. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/f).

10. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

11. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft3).

12. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

13. D2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

14. D2419: Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

15. D2434: Standard Test Method for Permeability of Granular Soils (Constant Head).

16. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

17. D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

18. D2940/D2940M: Standard Specification for Graded Aggregate Material For Bases or Subbases for Highways or Airports.

19. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

20. D4832: Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

21. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. State Department of Transportation (DOT):

1. GDOT Specifications: Georgia Department of Transportation, Road and Bridge Specifications.

E. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

1.03 CLASSIFICATION OF EXCAVATION

A. Excavation is part of the lump sum contract price for the spent deicing facility project. Excavation is not classified, except where rock excavation is authorized outside specified or indicated limits of excavation. The contractor shall use the Geotechnical and Soils report as basis for classification of excavations.

1.04 DEFINITIONS:

A. Percent Compaction or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.

B. Field Dry Density or Field Density: In-place density as determined by ASTM D1556 (Sand Cone Method), ASTM D2167 (Rubber Balloon Method), or ASTM D6938 (Nuclear Method).

C. Maximum Dry Density: Laboratory density as determined by ASTM D698 (Standard Proctor) or ASTM D1557 (Modified Proctor) and occurring at the optimum moisture content of the soil being tested.

D. Pipe Embedment: Comprised of the following or combination thereof:

1. Foundation: Required only when the native trench bottom does not provide a firm working platform or the necessary uniform and stable support for the install pipe.

2. Bedding: Placed directly underneath the pipe and brings the trench bottom to grade. Provides a firm, stable, and uniform support of the pipe.

3. Haunching: From bottom of pipe to springline.

4. Initial Backfill: From top of bedding or foundation to 6 inches above top of pipe, unless noted otherwise.

5. Final Backfill: Above the initial backfill to the original or finish grade.

6. Backfill: Includes initial and final backfill.

1.05 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Qualifications of Independent Testing Laboratory, four weeks prior to earthwork.

2. Temporary excavation and shoring drawings for worker protection in accordance with the General Conditions.

3. Asbestos test results.

4. Gradation analysis.

5. Dewatering plan including disposition of groundwater.

6. Manufacturer's catalog data and a sample of prefabricated drainage panel and filter fabric with manufacturer's installation instructions and details.

7. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics.

8. Test and Evaluation Reports:

a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.

b. Grain-size analysis.

c. Laboratory compaction characteristics of soils.

d. Water content.

9. Geotextile:

a. At least two weeks prior to shipment, submit manufacturer's certificate of compliance and physical property data sheet indicating that requirements for materials and manufacture are in conformance as specified.

b. For informational purposes only, submit manufacturer's printed installation instructions.

10. Compaction method and removal sequence of shoring.

11. Mix design and test results for controlled low-strength material (CLSM) as specified in Section P-153.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Sustainability Standards Certifications.

C. Sample backfill materials in accordance with ASTM D75.

D. Provide verification from testing laboratory that materials contain less than 1 percent asbestos by weight or volume. Submit asbestos report from testing laboratory to Engineer for acceptance.

E. Testing will be provided by the Owner as specified. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.

F. Provide testing in accordance with Part 3 of this section.

1. Employ an independent testing laboratory with the following qualifications: Accreditation by the American Associates of State Highway and Transportation Officials (AASHTO) Accreditation Program.

2. Minimum of three years experience in sampling, testing and analysis of soil and aggregates, and monitoring field compaction operations. Minimum of three references from previous work.

G. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.07 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. Provide geotextile fabric in rolls wrapped with protective covering to protect geotextile fabric from mud, dirt, dust, and debris. Label each roll of geotextile fabric with number or symbol to identify production run.

C. Protect geotextile fabric from sunlight during transportation and storage. Do not leave geotextile fabric exposed to sunlight for more than two weeks during installation operations.

1.08 SITE CONDITIONS:

A. Existing Conditions:

1. Boring Logs: Logs of borings are included in the report and indicate conditions encountered only at test boring locations. Nothing in the contract documents shall be construed as guarantee that other materials will not be encountered or that proportion of materials will not vary from proportions shown on the logs of test borings.

PART 2 - PRODUCTS

2.01 BACKFILL MATERIALS:

A. Suitable Material: Material from on-site excavation and/or permitted off-site sources that meets all of the specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material is suitable.

B. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

1. Organic clay, organic silt, or peat; as defined in ASTM D2487 .

2. Vegetation, wood, roots, leaves, and organic, degradable material.

3. Stones or rock fragments over 6 inches in any dimension.

4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.

5. Ice, snow, frost, or frozen soil particles.

C. Bedding: As per specification D-701, Pipe for Storm Drains.

D. Initial Backfill: As per specification D-701, Pipes for Strom Drains and P-152, Excavation and Embankment.

E. Final Backfill: Suitable, unclassified material excavated from trench; free of rocks with dimensions greater than 1/2 the compacted lift; and rocks provide less than 50 percent of the final backfill volume.

F. Granular Fill:

1. As per specification D-701, Pipes for Strom Drains and P-152, Excavation and Embankment.

2.02 EQUIPMENT:

A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that dewatering support systems are in place before commencing with excavation.

B. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.

2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.

C. Verify that fill materials submittals have been accepted by Engineer before commencing with work requiring the use of these materials.

D. Verify that erosion and sediment control measures are in place and functioning properly.

E. Immediately notify the Engineer if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.

F. Test Pits:

1. Test pits for the purpose of locating underground pipeline or structures in advance of the construction shall be excavated and backfilled by the Contractor at the direction of the Engineer. Test pits shall be backfilled immediately after their purpose has been satisfied and the surface restored and maintained in a manner satisfactory to the Engineer.

2. Excavate test pits to field verify the locations of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Engineer if conflicts are encountered.

3.02 PREPARATION:

A. Underpin adjacent structures that could be damaged by excavation work.

B. Cut pavement with saw or pneumatic tools to prevent damage to remaining pavement. Dispose of large pieces of demolished pavement before proceeding with excavation.

3.03 PROTECTION OF IN-PLACE CONDITIONS:

A. Support and protect from damage – existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.

B. Excavation Near Existing Structures:

1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual

excavation in work to be done when incidental to normal excavation and under items involving normal excavation.

2. Excavate test pits near, or at intersection with, existing utilities or underground structures to determine the exact location of existing features.

C. Excavation Near Private Property:

1. Enclose uncut tree trunks adjacent to work in wooden boxes of such height necessary to protect tree from injury due to piled material, equipment, or operations. Operate excavating machinery and cranes so as to prevent injury to overhanging branches and limbs.

2. Protect cultivated hedges, shrubs, and plants which would otherwise be damaged by the work.

3. Where protection of vegetation is not possible, dig up, temporarily transplant, and maintain. After active construction operations in the area have ceased, transplant vegetation to the original positions and provide water and nursery care until growth is re-established.

4. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces. Provide protection on pavement or tracks if construction traffic is unavoidable.

3.04 RESTORATION:

A. Restore private property and structures promptly. Begin restoration work within 24 hours of when damage occurred.

B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.

C. Damaged Trees To Remain: Cut all damaged branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of grafting wax or tree healing paint. Replace damaged trees which subsequently die or continue to show lack of growth due to damage.

D. Cultivated Vegetation: Includes, but is not limited to: hedges, shrubs, and plants. Vegetation that is damaged shall be replaced with equal kind and of at least the quality before work began.

3.05 TRENCH EXCAVATION:

A. Provide dewatering system to allow for working conditions in dry, stable soil. Properly dispose of water to avoid damage to property and in accordance with laws and regulations. Lower groundwater table prior to excavation and keep a minimum of 24 inches below lowest excavation subgrade until structure has sufficient strength to withstand soil and water pressures.

B. Trenching and excavation protections – as per specification D-701, Pipe for Storm Drains.

C. Preserve material below and beyond the lines of excavations.

D. Locate stockpiled excavated material at least 3 feet from edge of excavations to prevent cave-ins or bank slides.

3.06 AUTHORIZED OVER-EXCAVATION:

A. Remove rock for a depth of 6 inches and backfill with bedding material.

3.07 UNAUTHORIZED EXCAVATION:

A. Contractor is responsible for backfilling unauthorized excavations with bedding material.

3.08 BACKFILL:

A. Fill to lines and grades necessary to provide finish grades.

B. Use a placement method that does not disturb or damage other work or existing features.

C. Maintain fill materials within 3 percent of optimum moisture, to attain required compaction density.

D. Place and compact material in equal continuous layers.

E. Maximum compacted depth is 6 inches for aggregate materials and 8 inches for soil materials, unless noted otherwise.

3.09 COMPACTION:

A. As per specification D-701, Pipes for Strom Drains and P-152, Excavation and Embankment.

B. Compaction Density: As per specification D-701, Pipes for Strom Drains and P-152, Excavation and Embankment.

Table 31 23 33-3

Area	Percentage of Maximum Dry Density as defined by ASTM D1557 (Modified Proctor)
Trench Backfill (under pavement, slabs)	95
Trench Backfill (under structures or within 25 feet of structures)	95
Trench Backfill (through embankment)	95
Trench Backfill (under exterior concrete slab and sidewalks)	95
Trench Backfill (in open or grassed areas)	92

3.10 UTILITY IDENTIFICATION:

A. Install marking tape over all site utilities, 12 inches below finish grade.

B. Install trace wire at top center; pull wire taut to remove any slack.

C. Extend trace wire to utility boxes, manholes and junctions to allow for connection to subsurface location equipment.

3.11 FIELD QUALITY CONTROL:

A. Compaction shall be deemed to comply with the specifications when no more than 1 test of any 3 consecutive tests falls below the specified relative compaction. The one test shall be no more than 3 percentage points below the specified compaction. The Contractor shall pay the costs for any retesting or additional testing of work not conforming to the specifications.

B. Where compaction tests indicate a failure to meet the specified compaction, the Owner will take additional tests every 50 feet (15 m) in each direction until the extent of the failing area is identified. Rework the entire failed area until the specified compaction has been achieved.

C. Perform particle size distribution and gradation analyses using ASTM D422 and following standard practices in ASTM D421. Perform 1 test for every source and submit results to Engineer for acceptance. Repeat the moisture density test for every 5,000 cubic yard of material used.

D. Perform field density testing in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

E. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with ASTM D1557 (Modified Proctor).

F. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Minimum of one test per 5,000 cubic yard of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

G. Location of field density tests shall be as recommended by the Engineer.

H. Frequency of field density tests:

Table 31 23 33-4	
Area	Frequency
Trench (Structural Areas)]	1 per lift for each 250 linear feet of trench
Trench (Non-Structural Areas)	1 per lift for each 500 linear feet of trench
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

I. Owner may retain the services of an independent testing laboratory to conduct confirmatory testing and inspection.

3.12 ADJUSTING:

A. Shrinkage:

1. Backfill to a height above finished grade which will allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.

2. Supply specified materials and build up low places, without additional cost if embankment or backfilling settles so as to be below the indicated level for proposed finished surface at any time before final acceptance of the work.

3.13 PROTECTION:

A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.14 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 31 23 33

SECTION 31 6000 -- PERMANENT EXCAVATION SHORING SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Permanent shoring that will be a part of the project construction and temporary shoring to retain excavation slopes and prevent damage to adjacent buildings, roads and utilities shall be designed and installed by the Contractor. The location, clearances, and other requirements for permanent shoring shall be as shown on the Contract Drawings.

B. Contractor shall be solely responsible for the design, installation, and performance of all shoring which shall meet, as a minimum, the requirements set forth in the Contract Documents.

1.02 RELATED SECTIONS

A. Structural Submittals

B. Structural Testing/Inspection Agency Services

1.03 BASIS OF PAYMENT

A. Bid price shall include the design of the system; furnishing and installing the system; complete performance of the tie-back testing program; redesign as a result of prototype tests or Architect/Structural Engineers' review; installation and monitoring of instrumentation; completion and submission of required reports; and any other incidentals necessary to the successful performance of the system.

B. Provide temporary excavation shoring as required. The cost of temporary shoring shall be included in the price for excavation.

C. Any element of the excavation shoring failing to meet the stated criteria shall be replaced by the Contractor at no additional cost.

1.04 DESIGN REQUIREMENTS

A. The basis for design of the permanent shoring system shall be determined by the Contractor, subject to approval by the Structural/Geotechnical Engineer.

B. Contractor shall determine the appropriate lateral design loads for the conditions at the project site for use in designing the temporary shoring.

C. The maximum movement at the crest of the slope behind the permanent tie-back wall, shall not exceed the following:

	General	Adjacent to Existing Structures
Lateral Movement	3/4 inch	1/2 inches

D. Overall Slope Stability for Permanent Shoring:

1. Overall slope stability of the retained earth mass shall have a factor of safety of at least 1.5 on any failure surface passing through the soil mass outside the tie-back system and exiting in the excavation.

2. Surcharge loads due to adjacent existing structures shall be included. Additionally, a surcharge of 250 psf shall be included due to construction traffic.

3. Stability shall be considered for both the short-term undrained condition and long-term drained condition.

4. A computer program such as PCSTABL5M should be used to evaluate the overall slope stability.

E. Tieback Anchors for Permanent Shoring:

1. Tieback anchors shall be designed and tested to resist the total lateral design loads determined by the Contractor and approved by the Structural/Geotechnical Engineer.

2. Tieback anchors shall be designed for a factor of safety of 2 applied to the design load against pullout.

3. The bonded length of the anchors and bond stresses used in design shall be subject to approval by the Structural/Geotechnical Engineer.

4. Tieback anchors in permanent excavation shoring shall be provided with long term corrosion protection for their full length including all bearing plates, nuts, etc., used to transfer the anchor load to the shoring wall.

5. Tieback anchors shall be installed, tested and locked off before any excavation proceeds below any tieback level.

F. Vertical Members for Permanent Shoring:

Because of the proximity of the proposed tie-back wall to the existing Radar Facility, driving of piles for the wall will not be allowed. Therefore, the vertical members for the wall shall be installed by drilling. The type of vertical members (e.g., H-piles) to be used shall be determined by the Contractor, subject to approval by the Structural/Geotechnical Engineer.

G. Projections shall not extend out from the face of the completed wall more than 7 inches.

1.05 TEST REQUIREMENTS FOR PERMANENT TIEBACK ANCHORS

A. Tie-back anchors may be designed and installed by any method and procedure that will result in a system that performs satisfactorily and is not detrimental to existing ground conditions. Final anchor acceptance will be based on the performance or proof testing of each anchor.

B. Instrumentation shall be provided to measure wall movements in 3 directions for the full height of the wall and anchor bar elongations to an accuracy of 0.001 inches.

C. The first five tieback anchors and five percent of the remaining tieback anchors shall be performance tested.

1. Performance testing shall follow the loading cycles shown in the following schedule: (D.L. = Design Load for the anchor)

Each load in the schedule is applied to the tieback in the order listed. At each approximate load, elongation of the tieback is measured and recorded. In addition, the maximum load shall be held for 50 minutes.
While the load is maintained constant, the anchor movement in regards to a fixed reference point shall be recorded at 0 minutes, 30 seconds, 1, 2, 3, 5, 10, 30 and 50 minutes. Contractor shall then submit a record of basis of load, load wanted, load read, and gauge reading for each load step for each performance test, including elongation versus load plots, to the Architect/Structural Engineer for evaluation before locking off the anchor.

Cycle	Load	Cycle	Load
1	0 Tons	6	0.25 D.L.
	2 Tons		0.50 D.L.
			0.75 D.L.
2	0.25 D.L.		1.00 D.L.
	2 Tons		1.20 D.L.
			2 Tons
3	0.25 D.L.		
	0.50 D.L.	7	0.25 D.L.
	2 Tons		0.50 D.L.
			0.75 D.L.
			1.00 D.L.
4	0.25 D.L.		1.20 D.L.
	0.50 D.L.		1.50 D.L. (Hold for creep test)
	0.75 D.L.		1.00 D.L.
	2 Tons		1.00 D.L. (Lock-off Load)
5	0.25 D.L.		
	0.50 D.L.		
	0.75 D.L.		
	1.00 D.L.		
	2 Tons		

2. Test is acceptable if:

   a. Total elastic movement obtained exceeds 80 percent of the theoretical elastic elongation of the stressing length.

   b. Total elongation is less than the structural elastic elongation of the stressing length plus 50 percent of the bond length.

3. Test is acceptable for anchors in bedrock if a creep movement does not exceed 0.080 inch under maximum test loading held for a period of 24 hours.

4. Test is acceptable for anchors in soil if the creep movement does not exceed 0.08 inches during the final time increment of the performance test regardless of tendon length and load.

5. A time increment is one log cycle of time: i.e. 1 to 10 minutes, 5 to 50 minutes.

D. Tieback anchors which are not performance tested shall be proof tested.

1. Proof test shall be performed by incrementally loading the anchor in accordance with the following schedule. At each increment, the movement of the anchor shall be recorded to the nearest 0.001 inches with respect to an independent fixed reference point if possible. The jack load shall be monitored with a pressure gauge or load cell. The increments of load shall be: (D.L. = Design Load for the anchor)

   2.00 Tons
   0.25 D.L.
   0.50 D.L.
   0.75 D.L.
   1.00 D.L.
   1.25 D.L. (hold for creep test)
   1.00 D.L. (Lock-off Load)

2. Proof test results should be compared to the performance test results. Any significant variation from the performance test results warrants making a performance test on the next anchor. If any anchor fails the performance test, it will be judged unacceptable and replaced by a new anchor located not less than 6 inches from the failed anchor.

E. Projections shall not extend out from the face of the completed wall more than 7 inches.

1.06 CONSTRUCTION TOLERANCES FOR PERMANENT SHORING

A. Vertical Structural Elements shall not vary from true vertical alignment more than 1/8 inch per foot.

1.07 SUBMITTALS

A. Submit qualifications of Contractor required by this section at the time of bids.

B. Submit the following design calculations for permanent shoring for review by the Architect/Structural Engineer. Review will not relieve the Contractor of responsibility for satisfactory performance of the excavation shoring system.

1. Overall slope stability calculations. Show all assumptions, methods used, and calculations.

2. Design calculations for the vertical structural wall elements, connections, walers, lagging, etc. Also calculations of embedment factor of safety of vertical elements below the excavation level.

3. Design calculations for tied-back anchors.

C. Calculations and drawings of the excavation shoring system shall be stamped and signed by a professional engineer licensed in the project state.

D. Submit overall excavation plan with emphasis on phasing of excavation to coordinate shoring with other project excavation. Show sequence of excavation required for installation of all tied-back wall elements (i.e. vertical members, tiebacks, facing elements, etc.).

E. Submit plan for installation procedure for permanent tieback wall. Include location, sizes, methods of installation, testing, etc. for entire tieback wall system.

F. Submit plan, including test set-up to measure elongation of anchor bar and anchor movements, for conducting performance and proof tests on permanent tie-back anchors for approval a minimum of 10 days prior to starting tests.

G. Submit plans for long term corrosion protection of permanent anchors.

H. Submit instrumentation plan to include instruments, installation, reading, and reporting requirements for permanent shoring systems.

1.08 REPORTS AND RECORDS FOR PERMANENT SHORING SYSTEMS

A. Records and reports generated by the Contractor during the installation of the excavation shoring shall be furnished to the Architect/Structural Engineer in a timely manner. Records and reports shall include, but will not be limited to the following:

1. Records on all drilling, driving, concreting, and installing of various elements of the system.

2. Records of all performance and proof tests on tieback anchors.

1.09 QUALITY ASSURANCE FOR PERMANENT SHORING SYSTEMS

A. Structural Testing/Inspection Agency will observe shoring and installation, the tieback testing, (both performance and proof tests) and movement surveys; and report results to the Architect/Structural Engineer.

1.10 QUALIFICATIONS

A. Contractor shall be experienced in the successful design and installation of shoring systems of similar size and scope, as evidenced by at least 5 years of applicable experience and the completion of at least 10 similar projects.

1.11 SUBSURFACE CONDITIONS

A. Subsurface boring information for the site is included in the bid documents. The data is not intended as a representation or warranty of the continuity of such conditions. Owner will not be responsible for interpretation or conclusions drawn therefrom by the Contractor. The data is made available for the convenience of the Contractor and is not guaranteed to represent all conditions that may be encountered.

B. Contractor may examine the site and make his own subsurface explorations at no additional cost to the Owner. Notify Owner prior to making subsurface exploration.

1.12 EXISTING UTILITIES

A. Locate existing underground utilities by careful hand excavation. If utilities are to remain in place, provide protection from damage during construction operations.

B. Cooperate with Owner and utility companies in keeping their respective services and facilities in operation. Do not interrupt existing utility service to facilities occupied and used by Owner or others, unless written permission is given by the Architect and then only after temporary utility services have been provided.

C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult Architect immediately for directions.

D. Repair damaged utilities to satisfaction of utility owner.

1.13 EXISTING STRUCTURES AND ROADS

A. Make complete examination and survey of adjacent existing buildings roads, and other facilites to determine all facts necessary to design, construct and monitor excavation shoring system.

B. Regardless of review by Architect/Structural Engineer, Contractor shall be responsible for and repair any damage to the existing buildings and roads that is related to excavation and construction.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

PART 4 MEASUREMENT AND PAYMENT

4.1 METHOD OF MEASUREMENT

A. The Retaining Wall is a lump sum and shall not be measured separately for payment. This lump sum item shall include the completion of all related construction work as detailed in this section and all sections referenced herein, and all work detailed in the construction drawings related to the same as required to furnish and install the complete retaining wall.

4.2 BASIS OF PAYMENT

A. All work required to construct the Retaining Wall and related support structures, drainage and foundation systems will be paid as a lump sum. The price shall be full compensation for the design, fabrication, furnishing and placing of all material and for all labor, equipment, tools, and incidentals necessary to complete all related work.

B. Partial payments for the Retaining Wall pay item shall be made as follows:

1. Ten (10%) of the item will be payable on the first pay application submitted after work under the section has commenced.

2. The remaining ninety percent (90%) of the item will be prorated on each partial payment in respect to the percent complete of the Retaining Wall. Each partial payment shall be described in a payment schedule submitted by the Contractor and approved by the Engineer. The Contractor's payment schedule shall be based on the approved baseline schedule. After approval, the payment schedule shall not be adjusted unless there is a change to the baseline schedule impacting the performance of Retaining Wall work.
3. Payment will be made under:

Item	316000-1	Retaining Wall	Per Lump Sum

END OF SECTION 316000

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SECTION 31 62 13

AUGER CAST-IN-PLACE CONCRETE PILES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Furnish materials and install by auger cast-in-place concrete piles for compression**,** tension and/or lateral support and perform load tests as indicated and specified.

B. Piles shall be designed for compression, tension and lateral loads as shown on contract documents. Contractor shall retain an engineer licensed in the State of Georgia to design the auger cast in place concrete piles.

C. The Contractor is responsible for the implementation of the specified test pile program including the selection of the final acceptance criteria for the production piles.

1.02 REFERENCES:

A. American Concrete Institute (ACI):

1. 214R: Recommended Practice for Evaluation of Strength Test Results of Concrete
2. 301: Standard Specifications for Structural Concrete
3. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
4. 305R: Hot Weather Concreting
5. 306R: Cold Weather Concreting
6. 311.4R: Guide for Concrete Inspection
7. 318/318M: Building Code Requirements for Structural Concrete and Commentary

B. American Society for Testing and Materials (ASTM):

1. A82: Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
2. A615/A615M: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
4. C33: Standard Specification for Concrete Aggregates
5. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
6. C42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

7. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens)

8. C150: Standard Specification for Portland Cement

9. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

10. C937: Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete

11. C1077: Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

12. D1143: Method of Testing Piles Under Static Axial Compressive Load

13. D3689: Method of Testing Individual Piles Under Static Axial Tension Load

14. D3966: Test methods for Deep Foundations Under Lateral Load

15. D4945: Standard Test Method for High-Strain Dynamic Testing of Piles

16. D5882: Standard Test Method for Low-Strain Integrity Testing of Deep Foundations

17. E329: Standard Specification for Agencies in the Testing and/or Inspection of Materials Used in Construction

C. American Welding Society (AWS):

1. D1.1: Structural Welding Code

2. D1.4/D1.4M: Structural Welding Code, Reinforcing Steel

1.03 DEFINITIONS:

A. Test Piles: Test piles are those piles chosen and tested for static and/or dynamic load testing.

B. Production Piles: Production piles are those piles installed and incorporated into the work after the performance and acceptance of pile load testing results.

C. Concrete Design Mix: An accepted mixture of cement grout or concrete with or without additives that is pumped into the borehole during auger pullback. The terms concrete and grout are used interchangeably in this Section.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit the following qualifications four weeks prior to the construction:

a. Qualifications of Contractor's concrete pile installer, as specified in Paragraph 1.05B.

b. Qualifications of Independent Geotechnical Engineering Consultant, as specified in Paragraph 1.05C.

c. Qualifications of Test Boring Contractor, as specified in Paragraph 1.05 D.

d. Qualifications of Independent Testing Laboratory that will load test the concrete piles, as specified in Paragraph 1.05E.

2. Pile Concrete Mix Design:

a. Submit pile concrete mix design and admixtures, as indicated and specified in Paragraph 2.02A. Submittal to include laboratory trial strength test data for the proposed design mix.

3. Steel Reinforcement:

a. Submit steel reinforcement placement drawings that indicate bar types, sizes and spacing, wire reinforcement, bends, splices, mechanical couplers and other reinforcement accessories.

(1) When mechanical couplers are required or permitted for use, submit the Manufacturer's installation instructions and certified load capacities for each type and size of coupler

b. Submit certified copies of the mill test reports for each lot of steel bar and wire reinforcement delivered to the site. Steel reinforcement materials shall comply with the composition and strength requirements of ASTM A82 and A615.

4. Pile Installation Plan:

a. Submit layout drawings and pile driving sequence and schedule.

(1) Layout drawing shall include pile identifications, installation sequence number, type, size, and pile tip elevation.

b. Submit list of equipment and accessories proposed for use.

5. Pile Installation Records

a. Submit daily pile installation records within two (2) days of pile installation. Daily records should include the following information:

(1) Project name and date

(2) Pile installation Contractor

(3) Closets test boring log

(4) Pile installation equipment

(5) Pile installation method and special advancement procedures

(6) Pile location and number

(7) Pile dimensions

(8) Steel reinforcement materials used

(9) Allowable as-constructed pile capacity

(10) Calculated borehole volume

(11) Volume of emplaced concrete

(12) Vertical deviations and horizontal offsets

(13) Finished elevations (incl. ground surface, pile tip and cut-off)

(14) Horizontal offsets

(15) Effective pile lengths

(16) Unusual occurrences and conditions

6. Concrete Strength Test Results - Submit the following data:

   a. Laboratory 7-day and 28-day compressive strength tests, per ASTM C39.

7. Pile Load Test Results - Submit the following data:

   a. Submit load test results within three (3) days of pile testing. Daily records should include the following information:

      (1) Project Name and date

      (2) Load Test Type

      (3) Name of testing laboratory and testing laboratory technician

      (4) Name and signature of supervising geotechnical consultant

      (5) Pile location and number

      (6) Pile dimensions

      (7) Weather conditions

      (8) Description of load application apparatus, including jack capacity

      (9) Description of test instrumentation

      (10) Time, load and movement readings

      (11) Calibration data

      (12) Groundwater level

(13) Unusual occurrences and conditions

8. As built drawings showing the actual locations of all the piles and their deviations from their design locations.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Auger Cast Pile Installer Qualifications:

1. Not less than three (3) years experience in the installation of concrete piles in similar conditions and of equal complexity as the proposed system.

2. Completed not less than five (5) successful concrete pile installation projects of similar scope and magnitude as the proposed system within the past ten (10) years.

3. Pile installation equipment operators and on-site supervisors with not less than three (3) years experience installing auger cast piles.

C. Independent Geotechnical Consultant Qualifications:

1. Consultant shall be a State of Georgia licensed Professional Engineer specializing in geotechnical engineering will be responsible for pile design calculations, designing and monitoring test piles, static pile load tests, production piles, and conducting high and low strain dynamic pile load and integrity tests.

2. Not less than five (5) years experience related to pile installation, pile instrumentation and pile testing.

3. Consultant's field representative shall have at least three (3) years supervisory experience in pile installation construction and monitored not less than five (5) similarly designed pile load tests.

D. Qualifications of Test Boring Contractor:

1. The Subcontractor used by the Independent Geotechnical Consultant to drill test borings, sample soils and rock, determine changes in stratigraphy and provide boring logs shall have a minimum of three (3) years experience drilling test borings.

2. Test borings shall be drilled and backfilled.

E. Independent Testing Laboratory Qualifications:

1. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor concrete piles of similar type and complexity as the proposed system.

a. Minimum qualifications of the testing laboratory or laboratories and their personnel shall comply with ASTM E329 and ASTM C1077.

2. Not less than five (5) years experience in static and dynamic testing of concrete piles. Methods of testing experience to include:

a. Static Axial Compressive Load Testing – ASTM D1143

b. Static Axial Tension Load Testing – ASTM D3689

c. Static Lateral Load Testing – ASTM D3966

d. High-Strain Dynamic Load Testing – ASTM D4945:

e. Low-Strain Integrity Testing – ASTM D5882

3. Have successfully tested at least three (3) concrete pile systems of similar type and equal complexity as the proposed system within the past six (6) years.

F. Comply with the material and testing requirements of Sections 03 21 00 and 03 30 00

G. Qualify welding procedures and personnel in accordance with AWS D1.1/D1.1M and D1.4/D1.4M.

H. Augering within six diameters of a newly constructed pile is not allowed until after the grout or concrete of the new pile has set for a minimum of 48 hours.

I. Do not load piles until they have reached their required 28 day strength and before a minimum age of 10 days.

J. The Engineers hall be present during the drilling of test borings and the installation and testing of piles.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. Deliver piles construction materials to Project site in such quantities and at such times to ensure continuity of installation.

C. Handle and store piles construction materials at Project site to prevent rust, physical damage and distortion.

1.07 JOB CONDITIONS:

A. Protect structures, underground utilities, and other construction from damage during the concrete pile installation work.

B. Boring logs are provided as part of the bid documents.

PART 2 - PRODUCTS

2.01 CONCRETE PILES:

A. Concrete piles shall be auger cast, reinforced, comply with ACI 301 and 318 standards and installed in accordance with accepted Project design documents. Installed concrete piles shall be as described:

1. Allowable Design Capacities:

    a. Per contract documents

2. Pile Dimensions:

    a. The Geotechnical Consultant is responsible for obtaining and using test boring and pile load test data to determine the production pile dimensions and tip elevations needed to meet the specified allowable capacities.

3. Material:

    a. Maximum Water-Cementitious Ratio: 0.40.

2.02 PILE CONCRETE MIX DESIGN:

A. The concrete pile design mix submitted by the Contractor shall adhere to following minimum standards:

1. Limit water-soluble chloride ions in concrete to the maximum percentage by mass of cementitious material permitted by ACI 318/318M, but not more than 0.06 percent.

2. Portland cement Type I or Type II shall be of same type, brand, and source and comply with ASTM C 150.

3. Fly ash and silica fume shall be limited to 25 percent by weight of the Portland cement mix.

4. Provide aggregates from a single source and that conform to the grading and quality standards of ASTM C33.

5. Water shall be potable and free of deleterious material that may affect steel reinforcement and the stability, setting, or strength of concrete.

6. Mineral admixtures, if used, shall be fly ash or natural pozzolan and conform to ASTM C618, Class C or Class F. Admixtures shall be compatible with other admixtures.

7. Fluidifiers shall conform to ASTM C937.

8. Air entrained with air content between 4 and 6 percent.

9. Minimum compressive strength, without reinforcement, of 5,000 psi at 28 days.

2.03 STEEL REINFORCEMENT:

A. The concrete pile reinforcement materials used by the Contractor shall adhere to following standards:

1. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

2. Plain Steel Wire: ASTM A82/A82M, plain cold drawn.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Do not start pile installation operations until earthwork fills have been completed or excavations have reached an elevation of 6 to 12 inches above bottom of footing or pile cap.

B. Provide written notifications to adjacent and affected landowners and building occupants a minimum of two (2) weeks prior to the start of pile installation efforts.

C. Do not conduct test borings, pile installation, or test pile load testing without the presence of the Contractor's Independent Geotechnical Consultant.

3.02 INSTALLATION:

A. Begin pile installations only after the completion of site grading work in the area of pile support. Pile installation work shall be performed using the materials and equipment indicated in the accepted Pile Design and Installation Plans, and as follows:

1. Advance continuous flight hollow stem auger to the design pile depth. Inject concrete into the auger stem during auger withdrawal while simultaneously maintaining a minimum positive pumping pressure of four psi.

    a. Use fixed auger leads that will hold auger firmly in position and in axial alignment with auger rig.

    b. The pressure gauge on the concrete injection equipment shall be in clear view of both the equipment operator and Engineer.

2. The rate of auger withdrawal shall be slower than the rate of concrete injection to allow for the filling of material pore space, fissures, and crevices. The volume of concrete pumped shall not be less than 15 percent of the calculated borehole volume.

    a. If the auger jumps upward during the withdrawal operation, reinsert the auger into the grout a minimum of five feet below the point that it jumped.

    b. Install corrugated pipe if unstable soil conditions are encountered. Casings, if used, are to remain in place.

    c. Corrugated casings shall be of sufficient strength and rigidity to prevent distortion and resist lateral pressures.

3. Should an impenetrable obstruction be encountered during borehole drilling or spudding that prevents pile placement at the required depth or within the specified tolerances, perform the following procedures after notifying and with the permission of the Engineer:

    a. Abandon the pile by cutting down the pile to one foot below the pile cap elevation and filling above the pile with structural fill, and

    b. Drill and install replacement pile at location and depth indicated by Engineer.

4. Cut off the top of the hardened concrete pile perpendicular to its longitudinal axis at the specified elevation.

B. Mixing Materials:

1. Use only accepted mixing and pumping equipment in concrete preparation and handling.

a. Use screen to remove oversized particles between mixer and pump or between mixer and agitator.

b. Remove oil or other rust inhibitors from mixing drums, stirring mechanisms, and other portions of equipment in contact with concrete before mixers are used.

2. Measure materials accurately by volume or weight as they are fed to mixer. Order of placing materials in mixer shall be as follows.

a. Water.

b. Fluidifier.

c. Other solids in order of increasing particle size.

3. Time of mixing shall be not less than five minutes.

a. Concrete may be held in mixer or agitator for a period of no more than two hours at temperatures below 70 degrees F or 90 minutes at temperatures above 70 degrees F.

4. Protect both fresh grout and curing grout from hot and cold weather related damage in accordance with ACI 305R and ACI 306R.

5. Concrete samples will be required to be taken by the Independent Testing Laboratory and tested for compressive strength per ASTM C39.

C. Steel Reinforcement

1. After the hole has been drilled and grouted, install the steel reinforcement cage within one hour of auger removal, as indicated:

a. The steel reinforcement cage shall be preassembled and placed as a single unit.

b. The reinforcement cage shall be straight and conform to the dimensions shown on the accepted design drawings.

c. The reinforcement bars and ties shall be free of rust, mud and any other deleterious materials that may hinder the bonding of the concrete and steel.

d. The reinforcement cage shall be centered in the borehole and set within established design clearances.

3.03 TEST PILES:

A. Install test piles in locations shown on drawings or as indicated by the Engineer.

1. Drill one test boring within 10 ft of each proposed test pile location to evaluate subsurface conditions. Test borings should be drilled to a minimum depth of 20 feet below proposed pile tip elevation, as indicated in Paragraph 2.01A.2.

2. Test piles shall be long enough to meet load testing acceptance criteria specified in Section 3.05.B.

3. Install test piles using the same equipment and under similar conditions to that of the permanent piles.

4. Cut the top of the concrete pile perpendicular to its longitudinal axis at the specified elevation.

3.04 LOW-STRAIN INTEGRITY TESTS:

A. Perform low-strain dynamic integrity testing of test piles in accordance with ASTM 5882.

3.05 STATIC LOAD TESTS:

A. Perform static load tests on test piles selected by the Engineer to verify driving criteria and to confirm allowable load of piles.

1. Wait a minimum of 10 days between the end of the test pile installation and pile load testing during Engineer's review.

2. Materials and equipment for testing, testing procedures and record keeping shall be provided in accordance with ASTM D1143, D3689 and D3966.

3. Test the compressive load of each pile in accordance with ASTM D1143.

4. After completing compression load testing, test the tensile load of each pile in accordance with ASTM D3689.

5. After completing tensile load testing, test the lateral load of piles selected by the Engineer in accordance with ASTM D3966.

B. Acceptance Criteria.

1. Acceptance criteria shall be as directed by the pile design engineer.

3.06 DYNAMIC LOAD TESTS:

A. Perform high-strain dynamic testing on 10 percent of piles during initial driving and re-striking to determine the force and velocity response of the pile during an axial impact event.

1. Materials and equipment for testing, testing procedures and record keeping shall be provided in accordance with ASTM D4945.

3.07 PRODUCTION PILES:

A. Install piles to elevations determined during load testing. Establish and maintain axial alignment of leads and piles before and during driving.

B. Install piles without exceeding the following tolerances, measured at pile heads:

1. Location: Maximum of six inches from designated horizontal location after pile installation is completed.

2. Deflection: Less than 2 percent from vertical.

3. Batter Angle: Maximum 2 percent deflection from required angle, measured when pile is aboveground.

4. Cut-off Elevation: Vertical tolerance shall not exceed -0"/+ ½" after pile installation is completed. Any piles exceeding this tolerance shall be cut off square with the pile axis.

C. If the load on any pile exceeds 110 percent of the specified load capacity, correct by installation of additional replacement piles, or other procedures approved by the Engineer.

D. Perform low-strain dynamic integrity testing of 25 percentage of production piles in accordance with ASTM5882.

E. If there is evidence that the strength of the production piles may be deficient, three representative cores will be required to be taken by the Independent Testing Laboratory and tested for compressive strength per ASTM C42/C42M.

1. Strength of concrete of the three cores shall be considered satisfactory if the average compressive strength is at least 85 percent of the 28-day design compressive strength and no core compressive strength is less than 75 percent of the 28-day design compressive strength.

2. If core test results are satisfactory and piles comply with requirements, solidly fill core holes with patching mortar and finish to match adjacent pile surfaces.

3. Piles will be considered defective if they do not pass tests and inspections.

F. Abandon and cut off rejected piles as indicated by Engineer. Leave rejected piles in place and install new piles in locations indicated by Engineer.

G. Cut off tops of piles perpendicular to their longitudinal axis and at elevations indicated.

3.08 CLEANING UP:

A. After the completion of pile installation work, the Contractor shall clean up his work area.

3.09 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 31 62 13

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SECTION 31 68 10

ROCK ANCHORS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Design, provide and test permanent prestressed Rock Anchors as indicated and as specified. The drawings indicate the number and location of the anchors. Provide rock anchors with a design load of 100 tons and an ultimate capacity of no less than twice the design load as indicated and in compliance with Contract Documents.

B. Provide 15-foot minimum (unbonded) prestressing length or longer as shown on the Contract Drawings.

C. Provide a bonding length to develop the anchor capacity with the specified safety factor, but not less than 20 feet into the bedrock.

D. Provide double corrosion protection for the anchorage, the unbonded length, and the bond length.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A36: Specification for Structural Steel

2. A416: Specification for Steel Strand, Uncoated Seven-wire for Prestressed Concrete.

3. A421: Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete.

4. A722: Specification for Uncoated High-Strength Steel Bar for Concrete Reinforcement.

5. A775: Specification for Epoxy-Coated Reinforcing Steel Bars.

6. A779: Specification for Steel Strand, Seven-Wire, Uncoated, Compacted, Steel-Relieved for Prestressed Concrete.

7. A882: Specification for Epoxy-Coated Seven-Wire Prestressing Steel Strand.

8. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).

9. C150: Standard Specification for Portland Cement.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Qualifications of Rock Anchor Designer, Installer and the Independent Testing Laboratory that tests the rock anchors.

2. Working drawings describing the rock anchor system intended for use thirty (30) days prior to commencement of rock anchor work. The drawings and calculations shall be stamped by a Georgia Registered Professional Engineer. Include the following:

   a. Description of the installation procedure including drilling methods, requirement for dewatering and groundwater control if needed, grouting procedure, and testing information for both production and test anchors.

   b. Description of equipment to be used in the installation and testing.

   c. Anchor type, size, bonded and unbonded length and capacity.

   d. Double corrosion protection system details for anchors and anchor heads.

   e. Spacers and centralizes and their locations.

   f. Manufacturer's literature describing materials and installation procedure.

3. Anchor Installation: Provide accurate daily records showing length of installed anchor, volume of grout intake, bond length of each anchor, and variations in grout pressure. The records shall be submitted at the end of each day.

4. If requested by Engineer, Submit 5-foot length of anchor having the double corrosion protection system and one complete stressing head assembly.

5. Anchor Test Results: Provide test results (performance and proof tests) of all anchors conforming to the loading schedule specified in this section.

6. Provide grout cube test results.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Prepare rock anchor design and submittals, under the direction of a Registered Professional Engineer who has a minimum of three years experience in of similar rock anchors within the past 10 years.

C. Rock Anchor Installer's Qualifications:

1. Not less than three (3) years experience in the installation of rock anchor systems of similar type and equal complexity as the proposed system within the past 5 years.

2. Completed not less than three (3) successful rock and/or systems of similar type and equal complexity as the proposed system within the past 10 years.

3. Provide drill operators and on-site supervisors with not less than three years experience installing rock anchors within the past 5 years.

D. The Engineer shall be present during the installation of rock anchor systems.

E. Provide the services of an Independent Testing Laboratory to test the rock anchors with the following qualifications.

1. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor rock anchors of similar type and equal complexity, as the proposed system.

2. Have not less than five (5) years experience in testing of rock anchors of similar type and equal complexity as the proposed system within the past 10 years.

3. Have successfully tested at least three (3) rock anchor systems of similar type and equal complexity as the proposed system within the past 5 years.

F. Double corrosion protection of rock anchors shall be in accordance with Class I Corrosion Protection System recommended in Chapter 6 of Geotechnical Engineering Circular No. 4 – Ground Anchors and Anchored Systems, Federal Highway Administration, Publication No. FHWA-IF-99-015. The double corrosion protection shall be provided for a design life of fifty years.

G. Grout cubes shall be taken on a daily basis on the days that grouting is performed in accordance with ASTM C109.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. Deliver rock anchors to the borehole in undamaged condition. Protect steel from dirt, rust, or other deleterious substances. Corrosion or heavy pitting will be cause for rejection. Store and handle in a manner to avoid damage or corrosion.

C. Store and handle all rock anchor materials in accordance with the manufacturer's recommendations. Damage to materials may be cause for rejection.

PART 2 - PRODUCTS

2.01 ANCHORS:

A. Rock anchors shall be fabricated from single or multiple elements of the following.

1. Steel bars conforming to ASTM A722, "Uncoated High-Strength Steel Bars for Prestressed Concrete."

2. Seven-wire strand conforming to ASTM A416, "Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete."

3. Wires conforming to ASTM A421, "Uncoated Stress-Relieved Wire for Prestressed Concrete."

4. Compact seven-wire strands conforming to ASTM A779, "Uncoated Seven-Wire Compacted, Stress-Relieved Steel Strand for Prestressed Concrete."

5. Epoxy coated strands conforming to ASTM A882.

6. Epoxy coated reinforcing steel bar conforming to ASTM A775..

2.02 GROUT:

A. Consists of Type II Portland cement conforming to ASTM C150 with a maximum water-cement ratio of 0.45 and an optional grout admixture used in accordance with the manufacturer's recommendations that will control bleed and retard set. No other grout admixtures will be permitted. Cement must be fresh and should not contain any lumps or other indications of hydration. The grout shall have a minimum 28-day compressive strength of 4,000 psi measured in accordance with ASTM C109.

1. Water: Use potable water free from injurious amounts of oil, alkali, organic matter, or other deleterious material.

2.03 SHEATH:

A. Provide a steel, PVC, polyethylene, or polypropylene tube as presented in the shop drawing submittal. Sheathing shall be gas and water-tight, resistant against chemical attacks and aging and capable of withstanding abrasion, impact and bending during handling and installation.

2.04 STEEL:

A. Provide steel that conforms to ASTM A36. Bearing plates shall be capable of developing 95 percent of the ultimate tensile strength of steel.

2.05 CENTRALIZERS AND SPACERS:

A. Provide centralizers fabricated from plastic, steel or other material appropriate for use with prestressing steel. Wood shall not be acceptable. Centralizer shall be able to support the tendon in the drill hole and position the tendon so a minimum of 0.5-inches of grout cover is provided and grout is permitted to freely flow around the tendon and up the drill hole.

B. Provide spacers fabricated from plastic, steel or other material appropriate for use with prestressing steel. Wood shall not be acceptable. Spacers shall be able to separate elements of multi-element tendon and shall permit grout to freely flow around the tendon and up the drill hole.

C. A combination centralizer-spacer may be used.

2.06 GROUTING EQUIPMENT:

A. Provide equipment sized to enable an anchor to be grouted in one continuous operation.

1. Grout Mixer: Use a grout mixer capable of producing a grout free of lumps and undispersed cement and that continually agitates the grout. Screen grouts to remove lumps in excess of 1/4-inch.

2. Grout Pump: Use a positive displacement pump equipped with a pressure gage to monitor grout pressures.

2.07 MISCELLANEOUS:

A. Grease for the stressing head assembly shall be a mastic corrosion inhibitor, waterproof, non-corrosive, non-hardening sealing compound.

B. Epoxy coating shall conform to ASTM A775.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Rock anchors shall be installed after the reinforced concrete base mat has been constructed and achieved its 28-day strength.

B. Install anchors at the designated locations and within 5 degrees of vertical.

1. Preparation of Anchor Hole: Use core drilling, rotary drilling or percussion drilling to advance the anchor holes. Drilling method selected shall be appropriate for subsurface conditions and the Contractor shall remain responsible for rock socket stability and removal of cuttings. Drill hole within 3 inches of the indicated location.

2. Anchor Insertion: Anchor bars/tendons shall be installed in accordance with the Contract Drawings and details and the recommendations of the anchor manufacturer. Anchor shall be inserted to desired depth without difficulty and in such a manner that sheathing, grout tubes and other anchor components are not damaged. Anchors shall not be subjected to sharp bends. When anchor cannot be completely inserted, it shall be removed and the anchor hole shall be cleaned or redrilled to allow proper insertion. Partially inserted anchors shall not be driven or forced into the hole.

3. Grout Injection: Inject grout from the lowest point of the anchor. Place grout using plastic grout tubes. Insert anchor prior to injecting grout. Restrict grout pressure to 1/2 psi per foot of depth. Do not disturb anchor for a minimum of 3 days after grout injection or until the grout has reached a compressive strength of 4000 psi.

4. Anchorage Installation: The anchor bearing plate and the anchor head or nut shall be installed perpendicular to the tendon, within plus/minus five (5) degrees and centered on the bearing plate, without bending or kinking of the prestressing steel elements. Wedge holes and wedges shall be free of rust, grout, and dirt. The stressing tail shall be cleaned and protected from damage until final testing and lock-off. After the anchor has met the specified requirements, the stress tail shall be cut to its final length according to the tendon manufacturer's recommendations.

3.02 PERFORMANCE TESTS:

A. Five (5) percent of the rock anchors or a minimum of three (3) rock anchors, whichever is greater, shall be performance tested in accordance with the procedures described below. The rock anchors to be performance tested shall be as indicated. The remaining rock anchors shall be tested in accordance with the proof test procedures as specified in Paragraph 3.03. Do not

test until seven (7) days after grout injection or until grout has achieved a compressive strength of 4,000 psi when tested in accordance with ASTM C109.

B. Calibration of Loading jack and Pressure Gage: Calibrate the loading jack and pressure gage as a set before the start of testing. Recalibrate if pressure movements are suspected of being erratic. Ram travel must be long enough to enable the rock anchor to deform.

C. The maximum test load in a performance test shall be held for ten (10) minutes. A load cell shall be used to monitor small changes in load during constant load-hold periods.

D. The jack shall be adjusted in order to maintain a constant load. The load hold period shall start as soon as the maximum test load is applied and the rock anchor movement, with respect to a fixed reference, shall be measured and recorded at 1 minute as well as at 2, 3, 4, 5, 6 and 10 minutes. If the rock anchor movement between one (1) minute and ten (10) minutes exceeds 1 mm, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the rock anchor movement shall be recorded at 15, 20, 30, 40, 50 and 60 minutes. The schedule of incremental loading and unloading for performance testing shall be as follows:

Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6
AL	0.25 DL	0.25 DL	0.25 DL	0.25 DL	0.25 DL
0.25 DL	0.50 DL	0.50 DL	0.50 DL	0.50 DL	0.50 DL
AL	AL	0.75 DL AL	0.75 DL 1.0 DL AL	0.75 DL 1.0 DL 1.2 DL AL	0.75 DL 1.0 DL 1.20 DL 1.33 DL 1.0 DL (lock off)
AL = Alignment Load DL = Design Load					

3.03 PROOF TESTS:

A. Do not install proof test anchors until the performance test anchors have been load tested in accordance with Specifications. Proof test anchors must meet the same criteria as the test anchors.

B. The proof test shall be performed by incrementally loading the rock anchor in accordance with the schedule noted below. The load shall be raised from one increment to another immediately after recording the rock anchor movement. The rock anchor movement shall be measured and recorded to the nearest 0.025 mm with respect to an independent fixed reference point at the alignment load and at each increment of load. The load shall be monitored with the primary pressure gauge. At load increments other than the maximum test load, the load shall be held just long enough to obtain the movement reading.

C. The maximum test load in a proof test shall be held for ten (10) minutes. The jack shall be adjusted in order to maintain a constant load. The load-hold period shall start as soon as the maximum test load is applied and the rock anchor movement with respect to a fixed reference shall be measured and recorded at 1, 2, 3, 4, 5, 6, and 10 minutes. If the rock anchor movement between one (1) minute and ten (10) minutes exceeds 1 mm, the maximum test load shall be held for an additional 50 minutes. If the load hold is extended, the rock anchor movements shall be recorded at 15, 20, 30, 40, 50 and 60 minutes. The schedule of incremental loading for proof testing shall be as follows:

Schedule

AL
0.25
0.50
0.75
1.00
1.20
1.33 DL
Reduce to lock off load of 1.0 DL

AL = Alignment Load DL = Design Load

3.04 ACCEPTANCE CRITERIA:

A. A performance-tested or proof-tested rock anchor with a 10 minute load hold shall be acceptable if the: (1) rock anchor resists the maximum test load with less than 1 mm of movement between 1 minute and 10 minutes; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

B. A performance-tested or proof-tested ground anchor with a 60 minute load shall be acceptable if the: (1) rock anchor resists the maximum test load with a creep rate that does not exceed 2 mm in the last log cycle of time; and (2) total elastic movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the unbonded length.

3.05 REPLACEMENT:

A. The failure of any anchor to meet the requirements specified herein will result in the rejection of the anchor and the installation of another anchor or anchors at no additional cost to the Owner at a location to be determined by the Owner.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 31 68 10

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SECTION 33 13 00 DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide disinfecting of water utility distribution systems as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Disinfection of water mains in accordance with AWWA C651, water storage facility in accordance with AWWA C652, and water treatment plants in accordance with AWWA C653; except as modified below.

1.02 REFERENCES:

A. American Water Works Association (AWWA):

1. C651: Disinfecting Water Mains.

2. C652: Disinfection of Water-Storage Facilities.

3. C653: Disinfection of Water Treatment Plants.

1.03 SEQUENCING:

A. Basic procedure for disinfecting water mains:

1. Inspecting materials to be used to ensure their integrity.

2. Preventing contaminating materials from entering the water main during storage, construction, or repair and noting potential contamination at the construction site.

3. Removing, by flushing or other means, those materials that may have entered the water main.

4. Chlorinating any residual contamination that may remain and flushing the chlorinated water from the main.

5. Protecting the existing distribution system from backflow caused by hydrostatic pressure test and disinfection procedures.

6. Documenting that an adequate level of chlorine contacted each pipe to provide disinfection.

7. Determining the bacteriological quality by laboratory test after disinfection.

8. Final connection of the accepted new water main to the active distribution system.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Supervisor qualifications.

2. Equipment list.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Regulatory Requirements:

1. Disinfection work shall be acceptable to Owner, local health authority and State health authority. If requirements of this section are in conflict with requirements of regulatory agencies, the latter shall govern.

C. Source Quality Assurance:

1. Perform Work in connection with disinfection under direction of experienced supervisor.

2. Use equipment in proper working condition and adequate for specified Work.

D. Prior to starting disinfection work, furnish detailed outline of proposed sequence of operation, manner of filling and flushing units, source and quality of water to be used, and disposal of wasted water.

E. Perform work in connection with disinfection under direction of experienced supervisor.

F. Use equipment in proper working condition and adequate for specified work.

1.06 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

1.07 PROJECT CONDITIONS:

A. Discharge of chlorinated water into watercourses or surface waters is regulated by the National Pollutant Discharge Elimination System (NPDES). Disposal of the chlorinated disinfection water and the flushing water is the Contractor's responsibility. Dechlorinate the disinfection water such that the chlorine residual does not exceed 0.5 mg/L and complies with NPDES Requirements for Georgia.

B. Schedule the rate of flow and locations of discharges in advance to permit review and coordination with Owner and cognizant regulatory authorities: City of Atlanta. The allowable locations of discharges are described below:

1. Any yard drain or sanitary sewer before the metered discharge point.

2. Removal by truck.

PART 2- PRODUCTS

2.01 OWNER-SUPPLIED PRODUCTS:

A. The Owner will provide potable water for the first disinfection effort. Submit request for use of water from waterlines of Owner 48 hours in advance. If bacteriological testing shows that the first disinfection effort was not successful, the Contractor will be charged, at the Owner's current rates, the cost of additional water for subsequent disinfection efforts.

2.02 MATERIALS:

A. Water: Use potable water for cleaning and disinfection.

B. Chlorine: Provide in accordance with AWWA C652.

1. Liquid Chlorine: Inject with a solution feed chlorinator and a water booster pump. Follow the instructions of the chlorinator manufacturer.

2. Calcium Hypochlorite (Dry): Dissolve in water to a known concentration in a drum and pump into the pipeline at a metered rate. Tablet form calcium hypochlorite may be used only for water mains up to 12 inches in diameter and less than 2,500 feet in length.

3. Sodium Hypochlorite (Solution): Further dilute in water to desired concentration and pump into the pipeline at a metered rate.

2.03 EQUIPMENT:

A. Submit list of equipment used for disinfecting work.

2.04 ACCESSORIES:

A. Chlorine Residual Test Kit: For measuring chlorine concentration, supply and use a medium range, drop count, DPD drop dilution method kit per AWWA C651, Appendix A.1. Maintain kits in good working order available for immediate test of residuals at point of sampling.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Isolate new work being disinfected from system to avoid possibility of contaminating materials entering distribution system.

B. Water Storage Facilities:

1. Remove debris and material not part of structural or operating facilities of tank.

2. Clean using high pressure water jet or other equally effective means to remove dirt and foreign material.

3. Cleaning shall:

a. Remove deposits of foreign nature.

b. Remove growths.

c. Broom walls, floor, and ceiling.

d. Avoid damage to structure.

e. Avoid contamination by workers and equipment.

4. Remove water, dirt, and foreign material and dispose.

5. Water used in cleaning reservoir shall be wasted before adding chlorinating agent to reservoir.

C. Method of disinfection for water containment devices and piping systems shall conform to AWWA C651.

D. Contractor shall be responsible for damages arising from direct contact of granular calcium hypochlorite with solvent welding materials used to join PVC pipe.

3.02 CHLORINE PREPARATION:

A. Liquid Chlorine:

1. Apply chlorine gas-water solution by means of solution feed chlorinating device or, if accepted by Engineer, dry gas may be fed directly through proper devices for regulating rate of flow and providing effective diffusion of gas into water within unit being treated.

2. Provide chlorinating devices for feeding solutions of chlorine gas that prevent backflow of water into chlorine cylinder.

B. Calcium Hypochlorite:

1. Prepare granular calcium hypochlorite as water mixture before introduction into unit. Make dry powder into paste and thin to approximately 1 percent chlorine solution.

2. To prepare chlorine solution, add 1 pound of calcium hypochlorite (65 to 70 percent available chlorine to 7-1/2 gallons of water.

3.03 PIPELINE PREPARATION:

A. After pressure and leakage tests complete, flush units thoroughly in accordance with AWWA C651 to remove foreign material.

B. Release entrapped air at high points and fill units with disinfecting agent and water to allow disinfecting agent to come in contact with interior surfaces.

C. If complete venting cannot be accomplished through available outlets, provide necessary corporation cocks and vent piping.

3.04 APPLICATION OF DISINFECTANT:

A. Point of Application:

1. Apply chlorinating agent at supply end of unit being disinfected.

2. For pipes, apply disinfectant through corporation cock installed in top of pipe.

3. Place tablets in accordance with AWWA C651.

B. Rate of Application:

1. Introduce water at controlled rate in order to regulate chlorine dosage.

2. Proportion rate of chlorine mixture flow to rate of water entering unit so chlorine dose applied produces at least 25 mg/L chlorine residual after period of 24 hours.

3. Method of determining rate of flow of water into unit being disinfected shall be accepted by Engineer.

C. Isolating Systems:

1. Keep chlorine gas-water disinfecting solution and contaminated water from flowing into units previously chlorinated and flushed.

D. Quality:

1. Retain chlorinated water in unit long enough to destroy non-spore forming bacteria.

2. Minimum retention period shall be 24 hours with chlorine residual at end of this period of not less than 25 mg/L (ppm).

E. Disinfecting Valves:

1. Operate valves and appurtenances while line or unit is being disinfected to ensure surfaces of valves are disinfected.

F. Swabbing:

1. Flush and swab pipe, fittings or valves that must be placed in service immediately with 5 percent solution of calcium hypochlorite immediately prior to assembly.

2. Secure acceptance from Engineer before using this method of disinfection.

G. Valve Operation: Performed by Contractor.

3.05 DISINFECTING METHODS:

A. Continuous Feed Method:

1. Introduce potable water into the pipeline at a constant measured rate. Feed the chlorine solution into the same water at a measured rate. Proportion the two rates so that the

chlorine concentration in the pipeline is maintained at a minimum concentration of **25** mg/L. Check the concentration at points downstream during the filling to ascertain that sufficient chlorine is being added.

B. Slug Method:

1. Introduce the water in the pipeline at a constant measured rate. At the start of the test section, feed the chlorine solution into the pipeline at a measured rate so that the chlorine concentration created in the pipeline is 100 mg/L. Feed the chlorine for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of at least 100 mg/L for at least three hours.

C. Disinfection of Valves, Blind Flanges, and Appurtenances:

1. During the period that the chlorine solution or slug is in the section of pipeline, open and close valves to obtain a chlorine residual at hydrants and other pipeline appurtenances. Swab exposed faces of valves and blind flanges prior to bolting flanges in place with a 1 percent sodium hypochlorite solution.

D. Disinfection of Connections to Existing Pipelines

1. Disinfect isolation valves, pipe, and appurtenances in accordance with AWWA C651, Section 4.7. Flush with potable water until discolored water, mud, and debris are eliminated. Swab interior of pipe and fittings with a 1 percent sodium hypochlorite solution. After disinfection, flush with potable water again until water is free of chlorine odor.

E. Disinfection of Tapping Sleeves and Line Stopping:

1. Flush exterior of pipe with potable water after removal of existing coating. Swab exterior of pipe with a 1 percent sodium hypochlorite solution. Disinfect per AWWA C651, Section 4.8. After completion of tapping and line stopping, swab interior of pipe, valves, and faces of flanges to be connected to bypass piping with a 1 percent sodium hypochlorite solution.

F. Confirmation of Residual:

1. After the chlorine solution applied by the continuous feed method has been retained in the pipeline for 24 hours, confirm that a chlorine residual of 10 mg/L minimum exists along the pipeline by sampling at air valves and other points of access , such as tapping valves.

2. With the slug method, confirm by sampling as the slug passes each access point and as it leaves the pipeline that the chlorine concentration in the slug is at least 50 mg/L.

3.06 FINAL FLUSHING AND TEST:

A. Following chlorination, flush unit or system in accordance with AWWA C651 until replacement water in system is proven to be comparable in quality to water which will enter unit or system .

B. Above acceptable condition of water delivered by each unit or system shall continue for at least 2 days, as demonstrated by laboratory examination of samples. Laboratory tests shall show chlorine residual, after final flushing, of less than 1 mg/L (ppm).

C. Repetition of Flushing and Testing:

1. If initial treatment results in unsatisfactory bacterial test, repeat disinfection until satisfactory results obtained.

D. Prevent entry of contaminated water into previously disinfected units or systems.

3.07 BACTERIOLOGIC TESTS:

A. Collect two sets of samples per AWWA C651, Section 5.1, deliver to a certified laboratory within six hours of obtaining the samples, and obtain a bacteriologic quality test to demonstrate the absence of coliform organisms in each separate section of the pipeline and in each structure after chlorination and refilling. Collect at least one set of samples from every 1,200 feet of the new water main and line stopping insertion point, plus one set from the end of the line and at least one set from each branch. At each connection to an existing pipeline, take two additional samples.

B. Repetition of Procedure: If the initial chlorination fails to produce required residuals and bacteriologic tests, repeat the chlorination and retesting until satisfactory results are obtained.

C. Test Facility Removal: After satisfactory disinfection, disinfect and replace air valves, restore the pipe coating, and complete the pipeline where temporary disinfection or test facilities were installed.

3.08 FIELD QUALITY CONTROL:

A. Owner will obtain samples for and submit to laboratory for analysis before reservoir placed in service.

B. If safe samples not obtained using above procedure, Contractor shall add additional chlorine in amounts necessary to obtain safe samples.

3.09 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 33 13 00

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SECTION 33 16 13.16

PRESTRESSED CONCRETE WATER STORAGE TANKS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all professional services, labor, materials, tools, equipment and incidentals as shown, specified, and required to design, furnish, install, test, and coat all prestressed concrete tanks of the specified type, diameter and capacity, capable of withstanding specified structural loads without excessive cracking or deflection.

2. Unit Responsibility:

a. It is the intent of this specification to assign unit responsibility to the tank manufacturer for the design, construction and testing of prestressed concrete tanks.

b. Design and construction of the complete tank system, which includes all aspects of the foundation, floor slab, walls, prestressing, shotcrete, all pipes and penetrations through the tank walls and/or floor, roof, and all other appurtenant features must be performed by the tank manufacturer or his authorized representative.

d. The tank manufacturer shall provide a representative on site at all times during any of the construction activities listed in above.

3. Included are:

a. Site work, excavation and fill, foundation, including pile installation, roof, concrete work, reinforcing, coating, testing, and appurtenances directly related to the prestressed concrete tanks unless otherwise specified.

b. Providing openings in and attachments to prestressed concrete tanks to accommodate the Work under this and other Sections and providing for prestressed concrete tanks all items required for which provision is not specifically included under other Sections.

4. Extent of prestressed concrete tanks Work is shown on the Drawings.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before prestressed concrete tanks Work.

C. Related Sections:

1. Section 03 30 00, Cast-in-Place Concrete.

2. Section 31 68 10, Rock Anchors.

3. Section 05 50 00, Metal Fabrications.

4. Section 05 52 00, Metal Railings.

5. Section 09 91 13, Field Painting.

6. Section 31 23 00, Excavation and Fill.

7. Section 31 62 13, Auger Cast-In-Place Concrete Piles.

8. Section 40 23 19.04, Ductile Iron Pipe and Fittings.

9. Section 40 23 19.06, High Density Polyethylene Pipe

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

2. ACI 301, Specifications for Structural Concrete.

3. ACI 305.1, Specification for Hot Weather Concreting.

4. ACI 306.1, Standard Specification for Cold Weather Concreting.

5. ACI 309R Guide for Consolidation of Concrete

6. ACI 318, Building Code Requirements for Structural Concrete and Commentary.

7 ACI 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.

8. ACI 350.3, Seismic Design of Liquid Containing Concrete Structures Commentary.

9. ACI 372R, Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.

10. ACI 506R, Guide to Shotcrete.

11. ACI CP-60, Craftsman Workbook for ACI Certification of Shotcrete Nozzleman.

12. ASCE 7, Minimum design loads for buildings and other structures.

13. ASTM A185/A185M , Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

14. ASTM A416/A416M, Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

15. ASTM A475, Specification for Zinc-Coated Steel Wire Strand.

16. ASTM A586, Specification for Zinc-Coated Parallel and Helical Steel Wire Structural Strand.

17. ASTM A603, Specification for Zinc-Coated Steel Structural Wire Rope.

18. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

19. ASTM A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

20. ASTM A821/A821M, Specification for Steel Wire, Hard-Drawn for Prestressed Concrete Tanks.

21. ASTM A882/A882M, Specification for Filled Epoxy-Coated Seven-Wire Prestressing Steel Strand.

22. ASTM A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

23. ASTM C33/C33M, Specification for Concrete Aggregates.

24. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

25. ASTM C94/C94M, Specification for Ready-Mixed Concrete.

26. ASTM C150/C150M, Specification for Portland Cement.

27. ASTM C260/C260M, Specification for Air-Entraining Admixtures for Concrete.

28. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.

29. ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

30. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

31. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

32. ASTM C920 Specification for Elastomeric Joint Sealants.

33. ASTM C1140, Practice for Preparing and Testing Specimens from Shotcrete Test Panels.

34. ASTM C1141/C1141M, Specification for Admixtures for Shotcrete.

35. ASTM C1218/C1218M, Test Method for Water-Soluble Chloride in Mortar and Concrete.

36. ASTM D395, Test Methods for Rubber Property—Compression Set.

37. ASTM D412, Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.

38. ASTM D638, Test Method for Tensile Properties of Plastics.

39. ASTM D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.

40. ASTM D1752-04a, Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

41. ASTM D2000, Classification System for Rubber Products in Automotive Applications.

42. ASTM D2240, Test Method for Rubber Property—Durometer Hardness.

43. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

44. AWS D1.1/D1.1M, Structural Welding Code – Steel.

45. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.

46. AWS D1.4/D1.4M, Structural Welding Code – Reinforcing Steel.

47. ANSI/AWWA D110, Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.

47. ANSI/AWWA C652, Standard for Disinfection of Water Storage Facilities.

48. NSF/ANSI 61, Drinking Water System Components – Health Effects.

49. US Army Corps of Engineers Specification CRD-C572, Specification for PVC Waterstop.

1.3 TERMINOLOGY

A. Terminology used in this Section shall comply with ANSI/AWWA D110 for definitions of terms relating to prestressed concrete tanks construction.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer's Qualifications:

a. All tank work shall be performed by a manufacturer that specializes in the design and construction of wire- and strand- wound, circular prestressed ANSI/AWWA D110 Type II concrete water tanks, which is capable of meeting all the requirements of these specifications.

b. No manufacturer will be considered qualified unless it has designed and built in its own name, or under the name of a subsidiary or division, at least 10 prestressed concrete tanks of equal or greater size as those specified herein, conforming to ANSI/AWWA D110 Type II, in the last 10 years, and which have been in successful service for a minimum of five years.

c. The steel shell design and epoxy injection procedure currently used shall have also been used in the tanks mentioned in paragraph 1.4.A.1.a, above.

2. Professional Engineer:

a. CONTRACTOR or tank manufacturer shall provide, as a direct employee of the tank manufacturer, a registered professional engineer legally qualified to practice in the same state as the Site. Professional engineer shall have been the engineer of record for at least 10 wire- and strand- wound, circular prestressed ANSI/AWWA D110 Type II concrete tanks.

b. Responsibilities include:

1) Reviewing prestressed concrete tanks system performance and design criteria stated in the Contract Documents.

2) Preparing written requests for clarifications or interpretations of performance or design criteria for submittal to ENGINEER by CONTRACTOR.

3) Preparing or supervising preparation of design calculations, tank and foundation design drawings, and related Shop Drawings.

4) Signing and sealing all calculations, tank and foundation design drawings, and Shop Drawings.

5) Certifying that:

a) Design of prestressed concrete tanks has been performed in accordance with performance and design criteria stated in the

Contract Documents, and

b) Design conforms to all applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.

3. Testing Laboratory:

a. Retain the services of independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete and shotcrete mixes.

b. Testing laboratory shall comply with the requirements of ASTM E329, and demonstrate to ENGINEER's satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated, in accordance with ASTM E329.

4. Welding:

a. Qualify procedures and personnel according to AWS D1.1/D1.1M, AWS D1.2/D1.2M or AWS D1.4/D1.4M, as required.

b. Submit certification that each welder employed on or to be employed for the Work possesses current AWS certification in the welding process with which welder will be working. Certifications shall be current and valid throughout the Work.

5. Shotcrete Crew:

a. Shotcrete crew foreman, nozzle operator, finisher and gun operator shall be qualified per ACI CP-60 and as specified herein.

b. Nozzle and gun operators shall have no less than two years experience in the shotcreting work similar to the Project. Shotcrete pool and ditch construction shall not be considered as qualifying experience.

B. Component Supply and Compatibility:

1. Obtain all prestressed concrete tanks components through a single source and from a single manufacturer.

2. Prestressed concrete tanks manufacturer shall review and approve, or prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by prestressed concrete tanks manufacturer.

C. Regulatory Requirements: Conform to the following:

1. Fabricate prestressed concrete tanks to comply with material verification and special

inspection requirements of the governing Building Code and Authorities Having Jurisdiction at the Site.

2. 29 CFR 1910, Occupational Health and Safety Standards, Sections 1910.24 and 1910.27, for stairs and ladders, respectively.

3. Interior tank coatings, curing compounds, concrete admixtures and any other materials, if required – other than the concrete itself – shall be listed in NSF/ANSI 61.

D. Pre-installation Conference:

1. Prior to erection of prestressed concrete tanks and associated Work, CONTRACTOR shall schedule and meet at the Site with the prestressed concrete tank manufacturer and installer, the installers of substrate construction to receive the prestressed concrete tanks, the installers of other Work in and around the prestressed concrete tank that follows the prestressed concrete tank Work, ENGINEER, and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the prestressed concrete tank Work, including, but not necessarily limited to the following:

   a. Review Project requirements and the Contract Documents.

   b. Review required submittals, both completed and yet to be completed.

   c. Review status of foundation work, including approval of surface preparations, structural loading limitations and similar considerations, including all quality assurance tests on foundation and piles (where applicable)

   d. Review detailed requirements of CONTRACTOR's proposed concrete and shotcrete design mixes.

   e. Review and discuss procedures for producing proper concrete and shotcrete construction, and to clarify roles of the parties involved.

   f. Review construction schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.

   g. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.

   h. Review regulations concerning code compliance, environmental protection, health, safety, fire and similar considerations.

   i. Review required inspection, testing, and certifying procedures.

2. Record the discussions of the conference and the decisions and agreements or disagreements reached and furnish a copy of the record to each party attending.

3. Record all revisions or changes agreed upon, reasons therefore, and parties

agreeing or disagreeing with them.

4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.5 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

a. Shop Drawings for the construction of prestressed concrete tanks system, including plans, elevations, sections, and details of entire system showing full dimensions and identification marks, joints, reinforcing details, anchorage, piping details, and roof, wall, and floor construction, including penetration locations and details. Indicate the locations of all appurtenances.

b. Foundation details shall include excavation, soil protection, and backfill, according to the requirements of Section 31 23 00 Excavation and Fill.

c. CONTRACTOR shall also note Work not supplied by tank manufacturer and who is to supply such Work.

2. Product Data:

a. Manufacturer's complete product information, specifications and installation instructions for prestressed concrete tanks components and accessories. Include material descriptions, dimensions, and profiles of individual system components, such as pre-manufactured pipe supports, ladder and safety cage, railing, hatches, manways, vent, waterstops, etc.

B. Delegated Design Submittals:

1. Design Data: Submit the following:

a. Laboratory Trial Batch Reports: Submit laboratory test reports for materials, and mix design tests, including list of concrete and shotcrete materials and proportions for the proposed concrete and shotcrete mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs, including admixtures.

b. Reinforcing steel shop drawings showing fabrication and placement in accordance with Section 03 30 00, Cast-in-place Concrete.

c. Design Calculations:

1) Complete calculations for the prestressed concrete tanks, as one package with the Shop Drawings. Structural calculations shall include all specified performance criteria, required load cases and load combinations used in the design and resulting forces. All calculations and assumptions shall be

presented so that ENGINEER can easily follow the progress and logic of CONTRACTOR'S professional engineer. The design analysis shall include the name and office phone number of the designer to answer questions during the shop drawing review.

2) Design calculations shall be signed, sealed, and dated by CONTRACTOR's professional engineer. State of professional engineer's registration, registration number, and name on seal shall be clearly legible.

C. Informational Submittals: Submit the following:

1. Delivery Tickets: Copies of all delivery tickets for each load of concrete or shotcrete delivered to or mixed at the Site. Each delivery tickets shall contain information in accordance with ASTM C94/C94M along with project identification name and number (if any), date, mix type, mix time, quantity and amount of water introduced.

2. Certificates.

a. Certification by professional engineer that prestressed concrete tanks system design is in accordance with performance and design criteria stated in the Contract Documents, and that design conforms to applicable local, state, and federal Laws and Regulations, and to prevailing standards of practice.

b. Welder's certifications.

c. Certification of acceptance by the Geotechnical Engineer for the tank subgrade, tank leveling course (if required), foundation drainage system (if required), and foundation, including piles where applicable. Certification shall be submitted prior to any tank floor construction.

3. Qualification Statements: Submit qualifications for the following:

a. Manufacturer.

b. Professional Engineer.

c. Testing Laboratory.

d. Shotcrete crew.

D. Closeout Submittals: Submit the following:

1. Warranty Documentation:

a. Copies of special warranties, as specified.

2. Record Documentation:

a. Immediately upon completion of the Work submit three copies of Record Drawings showing the actual in-place installation of all work specified in this Section.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery:

1. Deliver concrete reinforcing materials to the site bundled, tagged and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams. Deliver appurtenant equipment to the job site in an undamaged and ready to place condition.

2. Comply with Section 01 66 10, Delivery, Storage, and Handling.

B. Storage and Handling:

1. All materials used for concrete shall be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to ensure that segregation of the coarse and fine aggregate particles does not occur, and the grading is not affected.

2. Comply with 01 66 10, Delivery, Storage, and Handling.

1.7 SITE CONDITIONS

A. Site Information:

1. Information on subsurface conditions is available in the reports listed in the Supplementary Conditions.

2. Additional test borings and other exploratory operations may be made by CONTRACTOR at no additional cost to OWNER, provided such operations are acceptable to ENGINEER.

1.8 WARRANTY

A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranties.

B. Special Warranties:

1. Tank manufacturer shall guarantee workmanship and materials on the prestressed concrete tanks systems and components for a period of five years from date of

OWNER's acceptance. In case leakage or other defects appear within the five year period, tank manufacturer will make repairs promptly upon written notice by OWNER that such defects have been found. Leakage shall be defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from inside the tank.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. System Description

1. General:

a. Tank shall be designed and constructed in accordance with the provisions of ANSI/AWWA D110, Type II, and shall consist of a cast-in-place reinforced concrete floor, foundations, wire or strand wound prestressed shotcreted wall with an embedded steel shell diaphragm, concrete dome roof, baffle walls, piping, hatches, vents, and appurtenances as shown and specified.

b. Tanks shall be used for the storage of spent deicing fluid consisting of two types of propylene glycol (Type I and Type IV), surface deicing chemicals, potassium acetate, hydro-carbons and contaminated storm run-off. The concentration of spent deicing fluid will vary (glycol could be as high as 50%) and the pH can be as low as 3.5.

2. Tank Foundation:

a. Design and construct a tank foundation to support the tank under all load and operational conditions, in accordance with the findings of the geotechnical report and in accordance with all relevant codes.

b. Designed to accommodate all the additional loads that will be introduced by pipes entering the tank and inside the tank, especially the additional thrust forces that will be created by the mixing nozzles.

3. Tank Wall:

a. Shotcrete with full height, vertically fluted steel diaphragm, prestressed circumferentially by wrapping high strength steel wire. Waterstop shall be as required per tank design requirements and shall be fluorinated thermoplastic elastomeric rubber (TPER) and resistant to deterioration due to tank contents as outlined in section 2.1.a.1.b. Horizontal prestressing shall be continuous. Discontinuous prestressing tendons or strands will not be allowed.

4. Tank floor slab:

1) Designed as a cast-in-place reinforced concrete structural floor designed to transfer loads directly to the subgrade or piles when

applicable. Per geotechnical report, the floor slab shall be supported by auger cast piles.

2) Floor shall be placed continuously in a single monolithic pour to limit the the potential for leakage. Construction joints will only be allowed when shown in the approved submittals.

3) Floor shall be designed to resist bending moments and shears induced by loads specified. Tank floor slab reinforcing shall be designed in accordance with ACI 350. Minimum reinforcing shall be no less than that required for temperature and shrinkage, in accordance with ACI 350. Minimum bar size shall be #4.

4) Circumferential steel shall be added to the outside edge of the tank floor slab to resist circumferential bending moments that occur at the free edge of the circular plate. Circumferential steel shall be as calculated by rational analysis, but no less than 0.50 percent of the gross cross sectional area and placed within a minimum width of thirty inches.

4. Tank dome roof:

a. Roof shall be free-spanning of cast-in-place construction and have a rise to span ratio within the range of 1:10 to 1:12.

b. The dome roof shall be fixed or pinned to the tank wall. If dome is separated from tank wall, a positive means shall be provided to prevent lateral displacement of the dome. Columns or interior supports will not be allowed.

c. Dome design shall be based on elastic spherical shell analysis and shell thickness shall be governed by buckling or maximum stress considerations in accordance with ANSI/AWWA D110 but not less than three inches in accordance with AWWA D110.

d. Dome reinforcing shall consist of wire mesh or reinforcing bars as required by design, minimum reinforcing area shall be no less than 0.25 percent. Minimum thickness for buckling resistance shall satisfy the requirements of ACI 350, ACI 372, and ANSI/AWWA D110.

e. A circular prestressed dome ring shall be provided to resist dome thrust. The dome ring shall be prestressed to counteract the dead load and live load thrusts and shall be of sufficient cross section to resist applied prestressing force.

f. Design shall consider the bending, thrusts, and shears that result from prestressing of the dome ring and dome live load on the edge region of the dome.

B. Design Criteria:

1. Materials, design, workmanship and all other aspects of prestressed concrete tanks design and construction shall be in accordance with ANSI/AWWA D110 and ACI 372R except as modified herein.

2. Use the following loadings and requirements in the design calculations:

    a. Effective capacity of each tank: 1,250,000 gallons (excluding free board).

    b. Dimensions and elevations shall be as indicated on the Drawings.

    c. Provide a minimum of 24 inches freeboard between the maximum water level and the top of the tank wall at the dome/wall intersection.

    d. In general, loads and load combinations shall comply with the requirements of ANSI/AWWA D110, ASCE 7, and applicable Building Code.

    e. Dead Load shall be the estimated weight of all permanent imposed loads. Unit weight of concrete 150 pounds per cubic foot; steel 490 pounds per cubic foot.

    f. Live Loads: Internal pressures resulting from the water pressure at maximum overflow level. Unit weight of liquid 69.89 pounds per cubic foot.

    g. Roof Live Load: Roof live load shall be the more severe of snow, ice and other live loads per the requirements of the provisions of ANSI/AWWA D110, ASCE 7, and applicable Building Code. Construction loads shall also be considered in the design of the roof.

    h. Foundation Loads: Cast-in place reinforced concrete foundation shall be designed in accordance with the recommendations of the geotechnical report, and the soil bearing pressures shall not exceed the pressures specified therein. Effects of differential and total settlement and radial forces from the base of the tank shall be considered in design. Consideration shall be given to the effects of shrinkage, temperature, moisture gradients, and creep. The additional loads from the pipes entering and inside the tank will also be taken into consideration, including the thrust forces induced by the mixing system nozzles. If the tank is supported by piles, underfloor pipes and encasements shall be structurally integrated into the tank foundation.

    i. Seismic Loads: The effects of seismic loads shall be considered in the design of all structural and non-structural components of the prestressed concrete tanks system per ANSI/AWWA D110, ASCE 7, ACI 350.3, and applicable Building Code requirements.

        1) Site specific criteria is shown on the Drawings.

        2) The prestressed concrete tank is classified as a Category III Structure per the International Building Code, Seismic Design Category C, with an Importance Factor of 1.25.

3) Roof, walls, foundation and appurtenances shall be investigated for the effects of earthquake loads such as, but not limited to, induced impulsive and convective forces, uplift pressures on the roof caused by the height of the sloshing wave, etc.

4) Required seismic joints at the wall/foundation and wall/roof interaction shall be provided to resist dynamic seismic forces and its effects. Tank design engineer shall be responsible for selecting and determining adequacy of the joints for the design requirements specified above.

j. Wind Loads: Shall be per the requirements of ASCE 7 and applicable Building Code requirements.

k. Allowable Stresses:

1) Concrete wall: Per ACI 350, ACI 372R, and ANSI/AWWA D110.

2) Other segments: Per ACI 350.

l. Vent Capacity Requirements:

1) Maximum fill rate: 8,100 gallons per minute.

2) Maximum drawdown rate: 2,000 gallons per minute.

m. Overflow Rate: 8,100 gallons per minute with a maximum of six inches rise in the tank water level.

n. The operational loads in the tank will be very cyclical with the liquid levels changing all the time from empty to full in a matter of hours and being emptied thereafter, just to be filled again. Most of the year, especially during the summer months, the tank will be empty or filled with the minimum amount of fluid. To protect the pipes and the tank from overstressing, no more that ¾-inch to 1-inch settlement will be allowed on any portion of the tank floor or walls.

o. Design load will be based on the full operating level of the tank, including the additional freeboard the and emergency overflow level.

2.2 MANUFACTURERS

A. Manufacturer: Provide product of one of the following:

1. Crom Corporation

2. Precon Corporation

2.3 CONCRETE

A. Concrete shall be Class A as specified in P-615, Site Concrete. Concrete in contact with interior fluid contents, i.e. the entire tank floor and inside corewall, shall have Bio-San C500 admixture by Xypex or approved equivalent. Dosage per manufacturer at 1% by weight of cementitious materials content.

2.4 SHOTCRETE

A. Shotcrete shall conform to ACI 506R, and as modified herein.

1. The wet-mix process shall be employed for shotcreting.

2. Minimum compressive strength shall be 4,000 psi at 28 days.

3. Portland Cement: ASTM C150/C150M, Type I or II.

4. Fly ash mineral admixture: A maximum 25 percent cementitious material in the final cover coat may be replaced with fly ash, conforming to ASTM C618, Class F in accordance with ACI 350 and ANSI/AWWA D110.

5. Aggregates: ASTM C33/C33M, except local aggregates of proven durability may be used when acceptable to ENGINEER.

6. Water: Clean, free of oils, acids and organic matter.

7. Admixtures for shotcrete shall conform to C1141/C1141M. Do not use calcium chloride.

8. Shotcrete used for covering prestressing wire or strand shall consist of not more than three parts sand to one part Portland cement by weight. Additional coats of shotcrete shall consist of no more than four parts sand to one part Portland cement by weight.

9. Shotcrete in contact with prestressing steel shall have a maximum water-soluble chloride ion concentration of 0.06 percent by mass of cementitious material as determined by ASTM C1218/C1218M.

10. Shotcrete in contact with interior fluid contents shall have Bio-San C500 admixture by Xypex. Dosage per manufacturer at 1% by weight of cementitious materials content.

2.5 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type of concrete and shotcrete required.

B. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for each type of concrete or shotcrete required, complying with ACI 211.1 and the requirements of Section 03 30 00, Cast-In-Place Concrete.

C. Adjustment to Mixes: Mix design adjustments may be requested when characteristics of materials, job conditions, weather, test results or other circumstances warrant. Laboratory test data for revised mix designs and strength results shall be submitted to and accepted by ENGINEER before being incorporated into the Work.

2.6 STEEL DIAPHRAGM

A. Galvanized sheet steel diaphragm shall conform to ASTM A1008/A1008M and shall be a minimum thickness of 0.017 inches. It shall be vertically ribbed with reentrant angles. The back of the channels shall be wider than the front, thus providing a mechanical keyway anchorage with the concrete and shotcrete encasement. Weight of zinc coating shall be not less than G90 of Table 1 of ASTM A653/A653M

B. Diaphragm steel may be considered as contributing to the vertical reinforcing of the wall.

C. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to the waterstop.

2.7 NON-PRESTRESSED REINFORCING

A. Reinforcing bars shall be deformed in accordance with ASTM A615/A615M, ASTM A706/A706M where welding of reinforcing bars are required, and as follows:

1. Provide Grade 60 for all bars, unless indicated otherwise.

B. Welded Smooth Wire Fabric: Shall be in accordance with ASTM A185/A185M.

1. Furnish in flat sheets, not rolls.

C. Comply with Section 03 00 05, Concrete.

D. Seismic Cables:

1. If required, galvanized strand for seismic cables, shall meet the requirements of ASTM A416/A416M, Grade 250 or 270, before galvanizing, and ASTM A586, ASTM A603, or ASTM A475 after galvanizing. Zinc coating shall meet the requirements of ASTM A475, Class A or ASTM A603, Class A.

2. Strand for seismic cables shall meet the requirements of ASTM A416/A416M, Grade 250 or 270, and shall be protected with a fusion bonded, grit impregnated epoxy coating conforming to ASTM A882.

2.8 PRESTRESSING REINFORCING

A. Circumferential prestressing reinforcing:

1. Prestressing reinforcing shall be either uncoated cold drawn, high carbon wire or galvanized seven-wire strand.

2. Uncoated wire shall meet the requirements of ASTM A821/A821M, and have a minimum ultimate tensile strength of 210,000 psi.

3. Splices for horizontal prestressing reinforcing shall be ferrous material compatible with the reinforcing and shall develop full strength of the prestressing reinforcing. Wire splice and anchorage accessories shall not nick or otherwise damage the prestressing reinforcing.

2.9 ELASTOMERIC MATERIALS

A. Waterstops:

1. Waterstops shall be extruded from thermoplastic elastomeric rubber and be fluorinated to protect against chemical attack.. Do not use reclaimed or scrap material.

a. Tensile strength: 2,000 psi, minimum, per ASTM D638.

b. Ultimate elongation: 350 percent, minimum, per ASTM D638.

c. Waterstop profile and size shall be suitable for the hydrostatic pressure and movements to which it is exposed, and shall be chosen by tank design professional engineer.

B. Bearing pads: Shall be neoprene or natural rubber:

1. Neoprene bearing pads shall have a hardness of 40 to 50 durometer (ASTM D2240, Type A Durometer), a minimum tensile strength of 1,500 psi, a minimum elongation of 500 percent (ASTM D412), and a maximum compressive set of 50 percent (ASTM D395, Method A). Pads shall meet the requirement of ASTM D2000, Line Call-Out M 2 BC 410 A1 4 B14.

2. Natural rubber bearing pads shall contain only virgin natural polyisoprene as the raw polymer and the physical properties shall comply with ASTM D2000, Line Call-Out M 4 AA 4 14 A1 3 or M 2 BC 414 A1 4 C12 F17 for 40 durometer material.

C. Sponge Filler:

1. Sponge rubber filler shall be closed cell neoprene or rubber conforming to ASTM D1056, Grade 2A1 or ASTM D1752, Type 1 with compression deflection limited to 25 percent at 2 to 5 psi.

D. Epoxy Sealants:

1. Epoxy shall conform to the requirements of ASTM C881/C881M.

2. Epoxy used for sealing the diaphragm shall be, Type III, Grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy.

3. Epoxy used for placing the waterstop shall be Type II, Grade 2, and shall be 100% solids, moisture insensitive, low exotherm epoxy.

4. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.

5. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC, and steel.

E. Bonding Epoxy:

1. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to the requirements of ASTM C881/C881M.

2. Epoxy resins shall be a two-component, 100% solids, moisture-insensitive epoxy and shall be Type II, Grade 2.

2.10 APPURTENANCES

A. General:

1. Provide and install all accessories as specified and as shown on the Drawings.

B. Anchor Systems:

1. Conform to the requirements of Section 31 68 10, Rock Anchors.

C. Vapor Retarder:

1. 6 mil polyethylene vapor-barrier membrane.

D. Inlet and Outlet piping: Shall conform to the details on the drawings and piping specifications, as applicable. Piping shall be constructed in accordance with the Drawings. The mixing system will induce additional thrust forces on the tank floor potentially requiring additional rebar and thickening of the floor. The forces will be provided by the mixing system subcontractor.

E. Overflow and Weir:

1. Provide overflow and weirs designed to pass 8,100 gallons per minute of overflow at a maximum velocity of 15 feet per second per tank without causing any uplift pressure on the roof of the tank. In no case shall the height of the water over the weir crest exceed six inches. The overflow will however be designed in such a way that it can operate in conjunction with the odor control system when operational.

2. The overflow weirs shall be supported from the tank wall and exit the tank as shown on the Drawings.

F. Wall Manway:

1. Provide one 30-inch (nominal circular manhole with a minimum inside diameter) wall manway fabricated from type 316 stainless steel. Number, location and elevation of wall manways shall be as shown on the Drawings. Manways shall have hinged, davited cover. Manway appurtenances shall be as indicated in the Drawings.

2. Manway shall be Type CM-1, Chase Associates, Inc. or equal.

3. Provide stainless steel 316 rectangular wall manhole opposite to circular manhole on tanks, as indicated on Drawings.

G. Roof Hatch:

1. Lockable gasketed, 316 stainless steel roof hatch. All hardware shall be type 316 stainless steel. Number and location as shown on the Drawings.

H. Roof Ventilator:

1. ~~***Fiberglass***~~316 stainless steel with minimum 16-mesh type 316 stainless steel bird screen. The vent shall be mushroom type reinforced to withstand wind force without damage. Connection of vent to roof shall be gasketed and all fasteners shall be type 316 stainless steel. The ventilator will however be designed in such a way that it can operate in conjunction with the odor control system when operational.

I. Ladders and Rails:

1. Exterior:

a. An exterior staircase with regular landings and dome railing system of aluminum alloy 6061-T6 shall be installed as shown on the Drawings. Staircase shall comply with the requirements of Section 05 51 19, Metal Grating, Stairs and Railings.

b. Railing system shall comply with the requirements of Section 05 52 00, Metal Railings.

c. The staircase will be fabricated to support light fixtures along the extent of the staircase.

2. Interior:

An interior ladder of fiberglass ***or*** stainless steel with TS safety rail shall be installed as shown on the Drawings.

3. Ladder Safety Device:

a. For all ladders, provide fall prevention systems that consist of a safety belt, which snaps to a safety sleeve that slides on a galvanized steel carrier rail or stainless steel cable.

b. Carrier rail system shall be TS Safety Rail as manufactured by TS Products or equal.

M. Roof Openings for Instruments:

1. Openings in the tank roof for instrumentation furnished under Division 40 shall be type 316 stainless steel, flanged pipe of the size indicated in the Drawings and as required for proper instrument installation. Location and number is shown on the Drawings.

N. Drain:

1. Drain pipe shall be provided as shown on the Drawings.

2. The connection of the drainpipe to the tank floor shall be watertight.

3. Floor shall be sloped as indicated in the Drawings to facilitate tank draining.

O. Lightning Protection

1. Provide as specified in Specification 26 41 13. Any lightning protection system shall be a separate system and shall not be bonded to the tank structure per AWWA D110.

P. Visual Level Indicator

1. Indicator shall be mounted on the tank exterior at the location indicated in the Drawings and shall be painted steel construction ***or fiberglass***.

2. Provide demarcations at 12-inch intervals for the full water depth.

3. Include level float, stainless steel wire rope, attachments, pulley, and other hardware as required.

Q. Odor Control Connection

Add a 20-inch SS 316 flanged connection with wall plate and blind flange for odor control connection on side of roof in accordance with the drawings

2.11 DECORATIVE COATINGS

A. Conform to the requirements of Section 09 91 13, Field Painting, and as specified herein.

B. All ferrous metal surfaces in contact with tank water shall be coated with epoxy paint.

C. Exterior paint system shall consist of one of the following systems:

1. Two-coat Tnemec Series 156 Enviro-Crete Modified Waterborne Acrylate, color to be selected by the owner.

2. Coatings shall be applied to roof/dome and walls to 12 inches below finished grade.

PART 3 – EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the areas and conditions under which prestressed concrete tank is to be erected and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 GENERAL

A. Site Preparation:

1. CONTRACTOR shall prepare prestressed concrete tanks foundation and final grading in accordance with Contractor's design.

2. Geotechnical engineer shall submit written acceptance of subgrade prior to beginning Work.

3.3 CONCRETE

A. All concrete shall be conveyed, placed, finished, cured, and tested per the requirements of Section 03 30 00, Cast-In-Place Concrete.

B. Finishes:

1. Comply with the requirements of Section 03 30 00, Cast-In-Place Concrete.

2. Tank floor slab: Light broom finish.

3. Interior wall: Light broom finish.

4. Exterior wall: Fresno finish.

5. Exterior roof surfaces: Light broom finish.

3.4 SHOTCRETE

A. All materials, methods of preparation, mixing, field-testing, and curing shall conform to the requirements of ACI 506R, and shall be applied by experienced nozzlemen certified as outlined in ACI CP-60.

B. The nozzle shall be held at such a distance and position that the stream of flowing material shall be as near as practical to the surface being covered. Shotcrete shall be applied in such a way that it flows into position. No air pockets shall form and good bond shall develop

between reinforcing and shotcrete. Any deposit of loose sand shall be removed prior to placing of any succeeding layers.

C. Shotcrete walls shall be built up of individual layers of shotcrete no more than 2 inches thick. No less than two coats to a minimum total thickness of 1 inch shall be provided over the diaphragm on the inside on the inside of the tank.

D. All shotcrete shall be applied by or under direct supervision of experienced nozzlemen certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.

E. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.

F. No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.

G. No less than ⅛ in. thick shotcrete shall separate reinforcing steel and prestressing wire.

H. The diaphragm shall be encased and protected with no less than ***1.5*** in. of shotcrete in all locations.

I. Finish covercoat shotcrete shall be applied as soon as practical after the last application of wire coat. The total thickness of shotcrete shall not be less than one inch over the wire.

J. Shotcrete shall not be placed in freezing weather without provisions for protection of shotcrete against freezing. Shotcrete placement can start without special protection when the temperature is 35 degrees F and rising and must be suspended when the temperature is 40 degrees F and falling. The surface to which the shotcrete is applied shall be free from frost. Cold weather shotcreting shall be in accordance with ACI 301 and ACI 306.1.

K. Hot weather shotcreting shall be in accordance with the requirements of ACI 301 and ACI 305.1.

L. Shotcrete shall not be applied under strong wind conditions.

M. Shotcrete damaged by rain or frost prior to setting up shall be removed and replaced. CONTRACTOR shall obtain ENGINEER's approval prior to placing additional shotcrete over layers with potential damage from rain or frost.

N. Interior and exterior shotcrete shall be kept moist by fog spraying or sprinkling for a minimum of seven days. Curing compounds will not be allowed. Curing shall be started at soon as possible without damaging the shotcrete. Curing may be interrupted for subsequent application of prestressing and shotcreting.

3.5 FLOOR

A. After installation of below grade piping the wall footings shall be constructed to the dimensions shown on approved Shop Drawings.

B. Place vapor retarder membrane over prepared subbase, prior to floor placement. Installation of vapor retarder shall be per the requirements of Section 03 30 00, Cast-In-Place Concrete.

C. Prior to placement of floor, all piping that penetrates the floor shall be set and encased in concrete as required to provide watertight connections into the prestressed concrete tank.

D. Waterstops:

1. A continuous waterstop shall be cast into the wall footing and be positioned to be constructed into the wall. Waterstops shall be positively held from displacement during concrete placing and shall be supported without puncturing any portion of the waterstop. Continuously inspect waterstops during concrete placing to ensure proper positioning.

2. Perform splicing in waterstops by heat sealing adjacent waterstop sections in accordance with manufacturer's printed recommendations.

a. Material shall not be damaged by heat sealing.

b. Splices shall have tensile strength of not less than 60 percent of unspliced material's tensile strength.

c. Maintain the continuity of waterstop ribs and of its tubular center axis.

3.6 WALL

A. Core wall shall be constructed of shotcrete, encasing a continuous waterproof galvanized steel shell diaphragm.

B. A galvanized steel diaphragm shall be embedded in the prestressed wall to form a waterstop. Diaphragm may be located near the inner or outer face of the core wall. If near the inner face, it shall be covered with at least ***one and a half inches*** of shotcrete.

C. Galvanized steel Diaphragm shall extend the full height of the wall with no horizontal joints. Horizontal construction joints in the diaphragm will not be allowed.

D. Galvanized steel diaphragm shall be encased and protected with shotcrete no less than ***one and a half inches*** thick at all locations.

E. Galvanized steel diaphragm shall be epoxy bonded to a waterstop at the floor/wall connection.

F. Vertical joints within a wall panel shall be roll seamed or otherwise fastened in a fashion that results in a firm mechanical lock. All vertical joints in the diaphragm shall be sealed.

G. No punctures will be allowed in the diaphragm except those required for pipe sleeves, temporary construction openings, or special appurtenances. Details of such openings, as necessary, shall be approved by ENGINEER. All such openings shall be completely edge sealed with sealant.

H. Temporary wall openings may be provided for access and removal of construction materials from the tank interior subject to the approval of ENGINEER.

3.7 PRESTRESSING

A. Prestressing wire/strand shall be placed on the wall with a machine capable of consistently producing a stress in the wire within range of -7 percent to +7 percent of the stress required by the design. No circumferential movement of the wire along the tank wall will be allowed during or after stressing the wire. Stressing may be not be accomplished by drawing wire through a die or by another process that results in elongation of the wire.

B. Each coil of prestressing wire/steel shall be temporarily anchored at sufficient intervals to minimize the loss of prestress in case a wire breaks during wrapping.

C. Minimum clear space between prestressing wires shall be 0.125 inch or 1 wire diameters, whichever is greater when utilizing 8 gauge prestressing wire. Any wires not meeting the spacing requirements shall be respaced. Prestressing shall be placed no closer than two inches from the top of the wall, edges of openings, or inserts, nor closer than three inches from the base of walls or floors where radial movement may occur.

D. The band of prestressing normally required over the height of an opening shall be displaced into circumferential bands immediately above and below the opening to maintain the required prestress force. Bundling of the prestressing steel shall not be allowed.

E. Ends of individual coils shall be joined by suitable steel splicing devices capable of developing the full strength of the wire.

F. Each layer of circumferential prestressing shall be covered with a flash coat of shotcrete as soon as practical after prestressing. Flash coat mix shall have a minimum compressive strength of 4,000 psi and a W/C ratio not to exceed 0.42. Flash coat shall be applied in such a way that voids are not formed beneath the pre-stressing wire.

G. Total coating thickness over the outside pre-stressing wire shall be not less than 1 inch. Positive means shall be provided to control the coating thickness. The horizontal pre-stress wire shall be fully bonded to the prestressed concrete tank wall by means of shotcrete. Coatings, wrappings or other materials that reduce or prevent full bonding shall not be used. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps, or hollows. The complete shotcrete shall be moist cured for at least 7 days. Curing shall be started as soon as possible without damaging the finishing coat.

H. The initial tension in EACH wire shall be read and recorded to verify that the total aggregate force is no less than that required by the design. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.

I . Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive force equal to that shown on the design drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire or when removing a defective section of wire.

J. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.

K. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the design and as shown on approved drawings.

L. The tank construction company shall supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. The stress measuring equipment shall include: electronic direct reading stressometer accurate to within 2%, calibrated dynamometers and a test stand to verify the accuracy of the equipment.

M. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.

N. When multiple layers of wire are required, shotcrete cover between layers shall be no less than ⅛ in. thick.

3.8 ROOF

A. Domes shall be cast-in-place construction.

B. Cast-In-Place dome construction:

1. Dome shall be constructed to the dimensions and curvature as shown in the approved Shop Drawings.

2. Dome roof decking shall not vary from level to level, or the curvature shown, more than 0.25 inch in 10 feet or 0.5 inch maximum in 20 feet or more.

3. Dome shall be reinforced in accordance with the approved Shop Drawings with the spacing not varying more than 1.0 inch.

4. Dome shall be constructed to the thickness shown on the approved Shop Drawings. Screed rails shall be provided to ensure proper curvature and reinforcing cover.

5. Dome forms shall be designed to resist all forces acting with respect to its sloped surface. No portion of formwork shall be removed until the concrete has attained sufficient strength, and until the full circumferential prestressing force has been applied to the dome ring.

6 The exterior dome surface shall receive a coat of membrane-forming curing compound immediately after the final finishing operation. Curing compound shall be compatible with the decorative coating system and shall be applied to the dome in

accordance with the manufacturer's recommendations. Water curing may be used in conjunction with the curing compound.

3.9 CONCRETE REPAIR

A. All defects in concrete shall be repaired as required in Section 03 30 00, Cast-In-Place Concrete.

B. All cracks of any thickness shall be repaired prior to disinfection and leakage testing.

3.10 DECORATIVE COATINGS

A. Conform to the requirements of Section 09 91 00, Painting, and as specified herein.

B. All coatings shall be applied a minimum of 28 days after final application of concrete or shotcrete. Successfully perform hydrostatic testing of prestressed concrete tank before applying decorative coatings. Apply and cure coatings before starting disinfection.

C. All exposed concrete surfaces shall be coated. Surfaces to be coated shall be clean, free from laitance, dirt, grease, and foreign material. All defective surfaces shall be repaired to the satisfaction of the ENGINEER prior to application of coating. Application shall be in full accordance with manufacturer's instructions.

D. Tank interior shall not be coated.

E. Color will be selected by OWNER.

F. Protection of Aluminum from Dissimilar Materials:

1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, shall be protected with a coat of bituminous paint.

3.11 FIELD QUALITY CONTROL

A. Furnish services of independent testing laboratory to perform field quality control sampling and testing during concrete and shotcrete placement as follows:

1. Concrete: Comply with requirements of Section 03 30 00, Cast-In-Place Concrete, and as follows:

Concrete and Shotcrete Testing:

a. Compression Tests:

(1) Compression test specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 50 yards of

concrete/shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.

(2) Compression test specimens for concrete/shotcrete shall conform to ASTM C172/C172M for sampling and ASTM C31/C31M for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.

(3) Compression test shall be performed in accordance with ASTM C39/C39M. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.

b. Air Content Tests (concrete only):

(1) Air content tests shall conform to ASTM C231/C231M (Pressure Method for Air Content).

(2) Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.

c. Slump Tests (concrete only):

(1) Slump tests shall be made in accordance with ASTM C143/C143M.

(2) Slump tests shall be made whenever compression test specimens are made.

B. Prestressing wire:

1. Testing tension in pre-stressing wire as it is installed shall be completed according to ANSI/AWWA D110 section 5.6.1.7, with a calibrated stress-measuring device or a continuous stress-recording device. A written record of stress readings shall be maintained and delivered to the ENGINEER following the completion of pre-stressing and installation of the cover coats.

C. Survey:

1. Survey the tank foundation at 10-foot intervals around the perimeter of the tank to determine settlement. Survey at the following times:

a. Before the tank is filled.

b. After the tank is filled and the hydrostatic testing is complete.

2. In the event the tank is drained, also survey as described above after draining.

3.12 HYDROSTATIC TESTING

A. The tank shall be tested for watertightness upon completion.

B. The testing for watertightness shall be completed as follows:

a. Fill the tank with water to the maximum water level and let it stand for a minimum of 24 hours.

b. Inspect the exterior of the tank wall and footing for damp spots. Damp spots shall be defined as spots where moisture can be picked up on a dry hand, the source of which is from inside the tank.

c. Leakage through the wall or wall-base joint shall be repaired and the tank shall be retested using the above procedure.

d. Also refer to Section 03 05 10, Leakage Testing of Containment Structures.

3.13 ANNIVERSARY INSPECTION

A. Prestressed concrete tanks shall be inspected by OWNER and CONTRACTOR approximately one year after completion of the Work (prior to expiration of the general warranty period for the project). Inspection and remedial work, if required, shall be per the requirements of ANSI/AWWA D110, and shall cover tanks and appurtenances. Cost of anniversary inspection, including repairs, shall be considered as being included in the Contract price.

END OF SECTION 33 16 13.16

SECTION 40 05 90.02

STAINLESS STEEL SLIDE GATES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test stainless steel slide gates and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

2. A276: Standard Specifications for Stainless Steel Bars and Shapes.

3. B584: Standard Specification for Copper Alloy Sand Castings for General Applications.

4. D2000: Standard Classification System for Rubber Products in Automotive Applications.

5. D4020: Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials

B. American Welding Society Code.

C. American Water Works Association (AWWA):

1. C561: Fabricated Stainless Steel Slide Gates

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified.

2. Data for gate and actuator characteristics and performance.

3. Complete description of all materials, material thicknesses of all components.

4. Maximum bending stress and deflection of the slide under design head specified and indicated.

5. Installation drawings showing the details required for installation, dimensions, clearances and anchor bolt locations

6. Shop drawing data for accessory items.

7. Certified setting plans, with tolerances, for anchor bolts.

8. Manufacturer's literature as needed to supplement certified data.

9. Operating and maintenance instructions and parts lists.

10. For manufacturers not named provide a listing of reference installations as specified with contact names and telephone numbers.

11. Certified results of gate shop testing, including shop leakage test results of each gate at the design unseating head specified and indicated

12. Certified results of actuator shop testing from the actuator manufacturer.

13. List of recommended spare parts other than those specified.

14. Shop and field inspection reports.

15. Qualifications of field service engineer.

16. Recommendations for short and long-term storage.

17. Shop and field testing procedures and set up

18. Special tools.

19. Manufacturer’s product data, specifications and color charts for shop painting.

20. Motor shop test results.

21. The latest ISO 9001 series certification or quality system plan.

22. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1. One set of all special tools.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Gates shall be the product of one manufacturer.

C. Gates shall be manufacturer’s standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Slide gates and appurtenances must be fabricated, assembled and tested in the United States of America or Canada.

E. Welding: In accordance with latest applicable American Welding Society Code, ASME Welding Code, or equivalent.

F. Shop tests as specified, including shop leakage testing of each gate at the design unseating head to confirm compliance with the leakage rate specified and indicated.

G. The Contractor shall obtain the gates, actuators and appurtenances from the gate manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

H. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.

I. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. ‘Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of electrical connection:

   a. 2 person-days.

3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.

   a. 1 person-days.

4. Field Performance Testing: Field performance test equipment specified.

   a. 1 person-days.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

   a. 2 person-days.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

J. Manufacturer of gates shall have a minimum of five (5) operating installations with gates of the size specified and in the same service as specified operating for not less than five (5) years or manufacturer of gates shall utilize a Project Manager that is experienced in stainless steel gate design and construction. The Project Manager shall be an employee of the gate manufacturer and shall have designed a minimum of five (5) operating installations with gates of the size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. Ship electric actuators separate from the gate assembly.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Gate sizes and operating data are indicated in the Slide Gate Schedule.

2.02 MANUFACTURERS:

A. Stainless Steel Slide Gates:

1. Whipps

2. RW Gate Co.

3. Acceptable Equivalent Product.

a. Provide in accordance with Section 01 25 00.

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 SLIDE GATE CONSTRUCTION:

A. Provide all gates produced by a single manufacturer and designed for installation in the channels and structures as specified and indicated.

B. Gate Configuration: As indicated in the Slide Gate Schedule.

C. Provide all gates in conformance with AWWA C561 and as specified.

D. Self-contained, rising or non-rising stem, flush bottom type with self-adjusting seals.

E. Gates with adjustable wedges or wedging devices are not acceptable.

F. Provide all structural components 1/4-inch minimum thickness.

G. Gate assemblies shall be media blasted or passivated in accordance with ASTM A380 prior to shipment to remove all mill scale, weld splatter, discoloration, or other surface imperfections.

H. Leakage Rate:

1. Seating head and unseating head conditions: Leakage not to exceed 0.05 gpm per foot of seating perimeter.

I. Assembly to consist of the following:

1. Frame.

2. Slide.

3. Stem

4. Seals.

5. Benchstand with operator type as indicated in the Slide Gate Schedule.

J. Materials:

1. Frame Assembly and Retainers: ASTM A240 Type 316L stainless steel.

2. Slides and Stiffeners: ASTM A240 Type 316L stainless steel.

   a. 1/4-inch minimum thickness.

3. Seat, seals and facing: ASTM D4020 UHMW (Ultra-high Molecular Weight Polyethylene

4. Invert Seal for upward acting gates only: ASTM D2000 Neoprene or EPDM

5. Stems: ASTM A276 Type 316 stainless steel.

   a. Minimum diameter: 1-1/2-inch.

6. Lift Nuts: ASTM B584 Bronze

7. Floorstand and Wall Brackets: ASTM A276 Type 316L stainless steel

8. Gear Operator Housing: Cast aluminum or ductile iron

9. Hardware, studs and nuts: ASTM A276 Type 316 stainless steel

10. Anchor bolts: Type 316 stainless steel. Minimum diameter of 1/2-inch.

K. Slide:

1. Slide and reinforcing stiffeners welded to the slide.

   a. Stainless steel plate, minimum 1/4-inch.

   b. Reinforcement: Provide a minimum of two horizontal stiffeners welded to the slide and two vertical stiffeners welded to outside of the horizontal stiffeners.

   c. Provide slide to engage the guide a minimum of 1 inch on each side and have a minimum material thickness of a 1/4 inch,

      (1) Gates with the width of the gate opening x maximum design head is 80 ft^2 or greater, provide the portion of the slide that engages the guide members 1/2 inch thick edge design where it engages the guide.

      (2) Gates with the width of the gate opening x maximum design head is 120 ft^2 or greater, provide the portion of the slide that engages the guide members 3 inch thick edge design where it engages the guide.

   d. Provide the stem connector constructed of two angles or plates welded to the slide. Provide a minimum of two bolts connecting the stem to the stem connector.

2. Deflection: Maximum of 1/720 of the span or 1/16 inch whichever is smaller, under design head specified.

L. Seals:

1. Provide a self-adjusting seal system suitable for the leakage, frequent cycling and velocities specified herein, and mounted such that there is no obstruction to the specified gate opening size.

2. Provide gates equipped with UHMW polyethylene seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide.

3. Extend the seat/seals to accommodate the 1.50 x the slide height with the gate in the fully open or fully closed position.

4. Provide all upward opening gates with a resilient flush bottom seal for sealing the invert of the gate.

5. Provide all downward opening weir gates with self-adjusting UHMW seat/seals across the invert member.

6. Provide all seals mechanically fastened to the frame or slide, force fit seals or seals attached with adhesive are not acceptable.

7. Provide all seats and seals to be field replaceable without the need to remove grout or concrete and without the need to remove the frame from the wall or wall thimble.

8. Gates using “J” or “P” seals are not acceptable.

M. Frames:

1. Provide frame assembly including guide members, invert members and yoke members constructed of formed stainless steel plate with a minimum thickness of 1/4-inch.

2. Provide gussets to support the guide members for unseating gates as required by the design head specified and indicated.

   a. Provide gussets extended to support the outer portion of the guide assembly and positioned to transfer the load to the anchor bolts or the wall thimble studs.

3. Provide frames for mounting type as indicated in the Slide Gate Schedule.

   a. Embedded

   b. Wall mounted with stainless steel anchor bolts and non-shrink, non-metallic grout or EPDM gasket

   c. Thimble mounted with stainless steel mounting studs and mastic gasket

4. Provide all wall mounted and thimble mounted gates with a flanged frame. Flat frame gates are not acceptable.

5. Provide all wall mounted and wall thimble mounted frames with a minimum guide weight of 11 lbs/ft and a minimum guide extension weight of 6.5 lbs/ft .

6. Provide guide extensions constructed of C-channel shape or similar. Angles are not acceptable guide extensions.

7. Frame Guides and Invert Members: Provide frames as a one-piece, fully welded assembly.

    a. Bolt-on yokes are acceptable when necessary to facilitate slide removal.

    b. Frames that require field assembly are not acceptable unless the overall frame size exceeds a size suitable for shipment on a standard flat bed truck.

8. Provide the frame guides extending to accommodate the entire height of the slide when the slide is in the fully opened position on upward opening slide gates or downward opening weir gates.

9. For self-contained gates, provide a yoke across the top of the frame guides with the yoke formed by two structural members fixed to the top of the guides to provide a one-piece rigid frame.

    a. Provide the yoke designed to allow removal of the slide.

10. Provide a rigid stainless steel invert member across the bottom of the opening.

    a. Invert member: Flush bottom type on upward opening gates with a minimum weight as specified

11. Provide a rigid stainless steel top seal member across the top of the opening on gates designed to cover submerged openings.

12. Provide a rigid stainless steel member across the invert of the opening on downward opening weir gates.

N. Stems:

1. Provide a threaded operating stem to connect the operating mechanism to the slide.

2. For rising stem gates provide the threaded portion engaging the operating nut in the manual operator or motor actuator.

3. For non-rising stem gates provide the threaded portion engaging the nut on the slide.

4. Minimum stem outside diameter of 1-1/2 inches.

5. Stem extension pipes are not acceptable.

6. Provide the stem constructed of solid stainless steel bar for the entire length

7. Tensile strength: Not less than 60,000 psi for stems.

8. Provide the stem threaded to allow full travel of the slide unless otherwise specified or indicated.

9. L/R: Not to exceed 200.

10. Provide the stem in accordance with AWWA C561, to withstand in tension the loads caused by an 80 pound effort on the manual crank or handwheel without exceeding 25 percent of the ultimate tensile strength of the stem material.

11. Motor Operators: Design stems to withstand in compression 1.30 x stalled output.

12. Provide the stem, in tension, designed to withstand a load caused by a 40 pound effort on the crank or handwheel without exceeding 1/5 of the ultimate tensile strength of the stem material.

13. Provide the threaded portion of the stem machined rolled or cut full depth ACME type threads with 16 micro-inch or better finish. Stub threads are not acceptable.

14. Provide stems of more than one piece joined by bronze or stainless steel couplings with the coupling bolted to the stem.

15. Provide dual stems for upward opening gates wider than 60-inch when the opening width is 2 x greater or more than the height of the slide. Provide dual stems for downward opening gates wider than 48-inch when the opening width is 2 x greater or more than the height of the slide.

16. Provide stems on manually operated gates with an adjustable stop collar to prevent over closing of the gate.

17. For rising stem gates, provide clear plastic covers with 1-inch graduations. Provide vent holes to prevent condensation.

2.05 STEM GUIDES:

A. Provide stem guides where required to maintain L/R of 200 or less for the unsupported length of the stem

B. Provide stem guides and brackets of Type 316L stainless steel.

1. Adjustable in two directions

2. Minimum Thickness: 1/4-inch.

3. Bushings: UHMW or bronze

2.06 WALL THIMBLES:

A. Provide where indicated on the Slide Gate Schedule.

1. Provide “F” thimbles for all systems not connected to piping systems

2. Provide “E” thimbles for all gates connected to piping systems

B. Provide “E” thimble depth equal to the thickness of the concrete wall in which the thimble is to be mounted.

C. For “F” thimbles in walls 36 inch thick and smaller provide thimble depth equal to the thickness of the concrete wall in which the thimble is to be mounted. For walls 36 inches thick and larger provide a minimum of 36-inch deep “F” thimble.

D. Provide a water stop continuously welded or stitch welded and sealed on both sides around the periphery of the thimble.

E. Provide wall thimbles of fabricated Type 316L stainless steel construction of adequate section to withstand all operational and installation stresses.

1. Minimum thickness including front face: 1/4-inch.

F. Provide the thimble square and plumb and the front face sufficiently flat to provide a mounting surface for the gate frame to achieve the specified leakage rate.

G. Provide the face of the wall thimble machined if recommended by the gate manufacturer. If the wall thimble is to be machined provide the front face with a minimum thickness of 1/4-inch after machining.

H. Provide a gasket or mastic to seal between the gate frame and the wall thimble.

I. For mounting to existing cast iron and ductile iron thimbles provide new slide gates suitable for bolting to existing thimbles. Contractor to verify thimble dimensions and bolting pattern and submit with shop drawings.

1. Clean existing thimbles and provide 1/4-inch thick elastomeric gasket

2.07 MANUAL OPERATORS:

A. Provide a manual gate operator for each gate so specified.

1. Provide all gates with slides 24 inches tall or taller with a gearbox operator suitable for use with a portable operator.

B. Type of operator as indicated in the Slide Gate Schedule.

C. Manually operated floorstands and benchstands:

1. Handwheel or crank operated floorstand or benchstand as indicated in the Slide Gate Schedule.

a. Handwheel: No gear reduction.

b. Handwheel or Crank Gearbox Operator: Single or double gear reduction.

c. Material: Cast ductile iron housing

2. Provide a threaded cast bronze lift nut to engage operating stem.

3. Provide roller bearings above and below a flange on the operating nut to support both opening and closing thrusts.

4. Operate gates under the operating head and design head, as specified and indicated, with no greater than a 40 pound effort on the crank or handwheel.

5. Gears, where required, steel with machined cut teeth designed for smooth operation.

6. Provide Type 304 or 400 Series stainless steel pinion shafts on crank operated benchstands and floorstands supported on tapered roller bearing or ball bearings with all components totally enclosed in a weatherproof housing with a removable cover.

    a. Design bearing arrangement for use with portable operators specified herein.

7. Provide mechanical seals on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist mechanism.

8. Provide lubricating fittings for the lubrication of all gears and bearings.

9. Floorstands: Provide a Type 316L stainless steel pedestal, constructed of minimum Schedule 40 tube and 3/8-inch thick base plates, designed to position the input shaft or crank operator or handwheel approximately 36-inch above the operating level.

10. Benchstands: Provide with a rectangular cast ductile iron base machined and drilled for mounting purposes. Provide all adaptor plates of Type 316L stainless steel.

11. Permanently attach or cast an arrow with the word "OPEN" on the floorstand, benchstand or handwheel indicating the direction of rotation to open the gate.

12. Handwheels: Minimum 15 inches, maximum 24 inches diameter and removable.

13. Cranks: Cast aluminum or stainless steel with revolving nylon grip and removable.

14. Provide two gearboxes for all upward opening gates 60 inch wide and larger and with opening widths greater than 2 x gate height. Provide two gearboxes for all downward-opening gates wider than 48 inch wide and larger and with opening widths greater than 2 x gate height.

    a. Provide Type 316 stainless steel interconnecting shaft.

    b. Provide flexible couplings at each end of the interconnecting shaft.

    c. Provide a handwheel or crank mounted on the pinion shaft of one of the gear boxes.

D. Extended Operators

1. Provide an extended operator system to bring the pinion shaft to 36 inches above the operating level utilizing chain and sprockets when the centerline of the handwheel on a non-geared operator is located 48 inches or more above the operating level.

2. Chainwheels are not acceptable.

3. Provide a removable Type 316L stainless steel cover to enclose the chain and sprockets.

4. If the centerline of the pinion shaft is 60 inches or less above the operating level a handwheel may be used with a gearbox in lieu of the extended operator system specified above.

E. Operating Nut

1. When indicated or specified provide 2 inch square operating nut and with a non-rising stem.

a. Nut Material: Bronze.

b. Where indicated and specified provide a Type 316L stainless steel or cast iron floor box be set in the concrete floor above the gate as indicated.

c. Provide one Type 316L stainless steel T-handle wrench for operation.

F. Floorstands and Wall Brackets

1. Provide Type 316L stainless steel floorstands of a height such that the handwheel or crank operated pinion shaft is located 36 inches above the operating level.

2. Provide Type 316L stainless steel wall brackets to support floorstands.

a. Provide wall brackets reinforced to withstand in compression a minimum of 2 x rated output of the operator with an 80 pound effort on the crank or handwheel.

2.08 ELECTRIC MOTOR ACTUATORS:

A. Provide in accordance with Section 40 23 13.03.

2.09 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.10 SHOP TESTING:

A. Provide motor shop testing in accordance with Section 40 23 13.03.

B. Assemble each gate and inspect for proper seating.

1. Check clearance between frame and disc seating surfaces.

C. Fully open and close each gate in guide system to insure gates operate freely as recommended by the gate manufacturer.

D. Conduct a shop leakage test at the design unseating head on each gate to confirm leakage as specified and indicated for Field Testing.

E. Operate floorstands and benchstands to insure proper assembly and operation.

F. Repeat tests until specified results are obtained.

G. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with shop drawings, manufacturer's printed instructions and as indicated.

B. Clean debris, dirt, and gravel, from inside of gates and channels before placing gates.

C. Install slide gates in completely assembled condition.

D. Erect and support slide gates in positions free from distortion and strain on appurtenances during handling and installation.

E. Inspect material for defects in workmanship and material.

F. Clean out debris and foreign material from gate opening and seats, test operating mechanisms to check proper functioning, and check nuts and bolts for tightness. Repair gates and other equipment which do not operate easily or are otherwise defective.

G. Set floorstand operators and stem guides so stems run smoothly in true alignment. Anchor guides firmly to walls. Check distances from centerlines of gates to operating level or base of floorstand and adjust if necessary, to suit actual conditions of installation.

3.02 FIELD TESTING:

A. Field testing will not be conducted without a procedure accepted by the Engineer calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 1 for checklist.

B. After installation of gates, and after inspection, operation, testing and adjustment have been completed by the manufacturer’s field service technician, conduct operating and leakage test for each gate in presence of the Engineer to determine its ability to operate as specified, and to operate smoothly without jamming under specified conditions.

C. Test all operators.

D. Leakage Test: Leakage not to exceed 0.05 gpm per foot of seal perimeter.

1. Conduct tests at design heads shown in the slide gate schedule.

E. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

F. Repeat tests until specified results are obtained.

G. Contractor to provide all water labor, piping, testing equipment for conducting tests.

H. Make all adjustments necessary to place equipment in specified working order at time of above tests.

I. Remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and testing accepted by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 40 05 90.02

SECTION 40 23 13.01

PROCESS VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and process valves and appurtenances as indicated and in compliance with Contract Documents.

1. Provide sizes and capacities as indicated or specified.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B1.20.7: Hose Coupling Screw Threads.

2. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.

3. B16.4: Cast-Iron Threaded Fittings, Class 125 and 250.

4. B16.10: Face-to-Face and End-to-End Dimensions of Ferrous Valves.

B. ASTM International (ASTM):

1. A48: Standard Specification for Gray Iron Castings.

2. A126: Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

3. A536: Standard Specification for Ductile Iron Castings.

C. American Water Works Association (AWWA):

1. C500: Metal-Seated Gate Valves for Water Supply Service.

2. C504: Rubber-Seated Butterfly Valves.

3. C509: Standard Specifications for Resilient-Seated Gate Valves for Water and Sewage Systems.

4. D102: Coating Steel Water-Storage Tanks.

D. NSF International (NSF):

1. 61: Drinking water system components Health effects

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Data, regarding valve characteristics and performance including Cv.

2. Shop drawing data for accessory items.

3. Manufacturer's literature as needed to supplement certified data.

4. Operating and maintenance instructions and parts lists.

5. Listing of reference installations as specified with contact names and telephone numbers.

6. Valve shop test results.

7. Qualifications of field service technician.

8. Shop and Field inspections reports.

9. List of recommended spare parts other than those specified.

10. Recommendations for short and long term storage.

11. Special tools.

12. Shop and field testing procedures and equipment to be used.

13. Number of service technician days provided and per diem field service rate.

14. Manufacturer’s product data and specifications for shop painting.

15. Provide a layout drawing, plan and section showing orientation of plug, gate, check, ball valves and actuators and nearest obstructions for each valve.

16. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

17. The latest ISO 9001 series certification or quality system plan.

18. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 SPARE PARTS:

A. Comply with requirements specified in Section 01 61 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Provide enclosures for the area classifications specified and indicated.

C. Contractor responsible for verifying outside diameter of pipe to be tapped.

D. Services of Manufacturer's Representative as stated in Section 01 43 00 and specified herein.

E. Manufacturer of valve shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

F. If equipment proposed is heavier, taller, different laying length or requires more operating space than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10 and as specified.

PART 2 - MATERIALS

2.01 DOUBLE ROTATING-REVOLVING DISC GATE VALVES 3-INCH (75 MM) TO 72-INCH (1800 MM):

A. Manufacturers:

1. Kennedy

2. J&S

B. Provide valve in compliance with AWWA C500, latest edition.

C. Provide valves in compliance with NSF 61 for all services.

D. Materials:

1. Valve Body, Bonnet, Discs, Wedges: Ductile Iron ASTM-A536 (65/45/12).

a. Provide valve body and bonnet of ductile iron full body thickness.

2. Scraper, Stem Nut, Disc and Body Seat Rings: B62-Low Zinc Bronze.

3. Ductile Iron Wedge Bearing Surfaces: Type 316 stainless steel ASTM-A276.

4. Stem: Type 316 Stainless Steel ASTM-A276.

5. Valve Bolts and Nuts: Type 316 Stainless Steel.

E. Valve Construction:

1. Rated Working Pressure:

a. Valves 3-inch through 54-inch: 250 psi

b. Valves 60-inch through 66-inch: 150 psi

c. Valves 72-inch: 100 psi

2. Exposed valves: Flanged OS&Y valves. Face-to-face dimensions to comply with ANSI B16.10, flanges to comply with ANSI B16.1.

a. Provide conventional packing in OS&Y valves.

b. Provide Type 316 stainless steel bolts and bronze nuts for stuffing box follower.

3. Buried Valves: NRS with gear operator:

a. Ends: Mechanical joint.

b. Provide conventional packing or double O rings in non-rising stem valves.

4. Where specified and indicated provide a bypass valve bolted to bottom or side of main valve body. Provide valve type and material as specified and indicated.

5. Provide valve body with two integrally cast flushing ports for gate valves sized 24-inch (600 mm) and larger.

a. Provide valve for flushing connections as indicated as specified herein.

b. Provide piping for flushing connections as indicated and in accordance with Section 40 23 19.04.

6. Provide two 360 degree ductile iron rotating discs, interchangeable and field replaceable without removal of valve body from the pipeline.

7. Provide self-adjusting bronze scrapers to allow valve to be mounted in the horizontal position or angle as shown from vertical or horizontal centerlines.

8. Provide Type 316 Stainless Steel stem with an integrally cast thrust collar.

9. Where required, provide each valve body with integrally cast electric motor mounting pads.

10. Provide a full port body design with full port completely through the entire valve body and seat rings to allow for pigging of pipelines.

    a. Valve in full open position shall provide a clear and unobstructed water way.

11. Provide valve body guides and tracks with a bronze bearing surface throughout the entire travel of the bottom side of a horizontally installed valve.

    a. Guide Contact Area: ASTM B21 Bronze.

12. Provide valve design to allow complete re-packing of valve stem under pressure when the valve is in the full open position.

13. End connections, provide type as indicated and specified:

    a. Flanged ANSI B.16.1 Class 125 (PN10) or Class 250 (PN16).

    b. Grooved.

    c. Mechanical Joint.

14. Provide all discs and wedges free of any type of pockets, linkages and pins.

F. Provide geared operators for all valves 16-inch (400 mm) and larger.

1. Gearing: Steel with enclosed cases.

2. Provide spur or bevel gearing as required by valve application and orientation.

3. Provide buried valves with totally enclosed gear cases.

4. Provide chainwheels where required as specified herein.

G. Testing:

1. Factory test each valve per AWWA C-500, latest Revision.

H. Provide a two part NSF-61 approved liquid epoxy on interior and exterior of valve.

2.02 RESILIENT SEAT GATE VALVES 3-INCH (75 MM) AND LARGER:

A. Resilient Seat Gate Valves:

1. Manufacturers-OS&Y Type Valves:

    a. Kennedy.

    b. Mueller.

    c. Seguro Valve.

2. Manufacturers-NRS Type Valves:

    a. US Pipe.

    b. American Cast Iron Pipe.

    c. Kennedy Valve.

    d. Mueller.

    e. Seguro Valve.

B. General:

1. Provide valves that conform to NSF Standard 61.

2. Non-potable water service: Provide resilient seat gate valves for all sizes indicated. If resilient seat valves are not available provide solid wedge gate valves.

3. Potable water service: Provide resilient seat gate valves for all sizes indicated. If resilient seat valves are not available provide double revolving disc gate valves.

4. Provide metallic seated valves conforming to AWWA C500 except as herein modified. (Valves larger than 48-inch (1200 mm), size shall comply with the intent of AWWA C500.)

5. Provide resilient seated valves conforming to AWWA C509 except as modified herein.

C. Materials:

1. Body and Bonnet: ASTM A536 ductile iron.

2. Wedge: ASTM A536 ductile iron encapsulated with EPDM.

3. Provide all other materials as specified in AWWA C500 and C509. Working water pressure:

Valve Size		Pressure Rating	
inch	**mm**	**psi**	**kPa**
3 to 16	75 to 400	250	1750
18 & Larger	450 & Larger	150	1050

4. Exposed Valves: Flanged OS&Y valves. Face-to-face dimensions to comply with ANSI B16.10, flanges to comply with ANSI B16.1.

5. Buried Valves: Mechanical joint or push-on joint ends, non-rising stem valves with operating nut in lieu of hand wheel. Provide gate boxes, steel extension stems or universal-joint operating rods with 2-in (50 mm) square operating nuts at upper end with coupling connected to valve stem to bring to operating nut to within 6 inches (150 mm) of ground surface.

6. Provide counterclockwise rotation to open valves.

7. Provide handwheels with arrow and word "open" to indicate open direction.

8. Provide geared operators for all valves 16-inch (400 mm) and larger. Gearing shall be steel with enclosed cases.

   a. Provide spur gears for buried valves with stems vertical

   b. Provide bevel gears where required by position of valve.

   c. Provide buried valves with totally enclosed gear cases to enclose both the gears and valve stuffing box and provide gasketed Type 316 stainless steel removable cover plates with Type 316 stainless steel fasteners to allow access to the stuffing box.

9. Chainwheels: Provide where required as specified herein. Provide beveled gear operator to mount chainwheel in vertical position. Provide valve mounted so that the arrow indicator will be visible from the floor level.

10. Provide conventional packing in OS&Y valves.

11. Provide conventional packing or double O rings in non-rising stem valves.

12. Valves capable of being repacked or O ring replaceable while under pressure.

13. Provide Type 316 stainless steel bolts and bronze nuts for stuffing box follower.

14. Provide bypass valves for valves 16-inch (400 mm) and larger where required for opening under pressure with a maximum 40-lb (18 kg) rim pull at the valve pressure rating.

D. Provide all gate valves with all internal and external wetted parts coated with a fusion bonded epoxy in accordance with ANSI/AWWA C550.

2.03 GATE VALVES - 3-INCH (75 MM) AND SMALLER:

A. Valves 1/2-inch (13 mm) to 2-inch (50 mm):

1. Working Pressure: 200 psi (1400 kPa).

2. Rising stem type.

3. Ends: Threaded ASME 1.20.1.

4. Materials:

   a. Body, Bonnet and Disc: ASTM A351 CF8M.

b. Stem and Gland: ASTM A276 Type 316 stainless steel.

c. Packing and Gaskets: PTFE.

d. Handwheel: ASTM A536.

B. Valves 2-1/2-inch (65 mm) to 3-inch (75 mm):

1. Working Pressure: ANSI Class 150.

2. OS&Y, bolted bonnet, solid or flexible wedge disc type.

3. Ends: Flanged ANSI B16.5.

4. Materials:

a. Body, Bonnet and Disc: ASTM A351 CF8M.

b. Stem and Gland: ASTM A276 Type 316 stainless steel.

c. Packing and Gaskets: PTFE.

d. Handwheel: ASTM A536.

2.04 GATE VALVES – NONMETALLIC:

A. Manufacturers:

1. ASAHI America, Inc.

2. Chemline.Pressure Rating at 30 to 120 degree F (-1 to 50 degrees C).

1. 1.5-inch (40 mm) through 8-inch (200 mm): 150 psi (1050 kPa)

2. 10-inch (250 mm): 110 psi (770 kPa)

3. 12-inch (300 mm): 75 psi (525 kPa)

4. 14-inch (350 mm): 75 psi (525 kPa)

C. Materials:

1. Body and Disc: PVC ASTM D-1784, Type 1, Grade 1, . Cell Classification 12454 for valves in PVC piping systems and CPVC Type IV Cell Classification 23447 for valves in CPVC piping systems.

2. Gate: CPVC, SBR lined or polypropylene for valves in PVC piping systems and CPVC for valves in CPVC piping systems.

3. Stem: PVC

4. Seals, O-rings and gaskets: EPDM

5. Handwheel: Polypropylene

6. Hardware and all metallic components: Type 316 stainless steel

D. Fabrication:

1. Non–rising stem design.

2. Solid thermoplastic construction with no metal to media contact.

3. Provide tapered cylindrical plug design for bubble-tight shutoff.

4. Provide a sealed position indicator.

E. Ends:

1. Flanged, 150 lb (ANSI Class 150) Rating.

2. Hardware: Type 316 stainless steel.

F. Operator:

1. Manual:

a. Handwheel

(1) Provide chainwheels where required as specified herein.

2. Manual operator for buried valves provide 2-inch (50 mm) square operating nut and Type 316 stainless shaft extension.

2.05 CAST STEEL GATE VALVES:

A. Manufacturers:

1. Williams.

2. Powell.

3. Velan.

B. General:

1. Type: Solid wedge flanged OS&Y gate valves with bolted bonnet.

2. Pressure Rating: ANSI 150 or 300 Class, as shown on the Process Piping Schedule.

3. Ends: Flanged, Raised face, ANSI B16.5.

4. Face to Face Dimensions: ANSI B16.10.

5. Provide renewable seat rings either threaded or welded.

6. Provide conventional packing.

7. Provide back seat bushing allowing valves capable of being repacked with the valve fully open while under pressure.

8. Bypass Valve:

a. Valve Size: 1-inch (25 mm) or as recommended by the gate valve manufacturer.

b. Valve Type and Pressure Class: ANSI 150 or 300 Class OS&Y globe valve, class to match gate valve pressure rating.

c. Materials: Same as gate valve.

d. Operator: Handwheel.

C. Materials:

1. Body and Bonnet: ASTM A216 Grade WCB.

2. Disc:

a. 2-inch to 6-inch (50 to 150 mm): ASTM A217 CA15.

b. 8-inch (200 mm) and Larger: ASTM A216 Gr WCB with 13 percent chromium stainless steel ASTM A182 Gr F6 face.

3. Stem: ASTM A479 Gr 410.

4. Seat Ring: ASTM A105 H/F CO-Cr A.

5. Packing: Non-asbestos.

D. Shop Testing: Provide in accordance with API 598.

E. Operators:

1. Manual:

a. Handwheel.

b. Gear Operator.

2. Where indicated, provide electric motor operators in accordance with Section 40 23 13.03.

2.06 KNIFE GATE VALVES – NON RISING STEM TYPE:

A. Manufacturers:

1. WEY.Delta.General:

1. Provide all valves fully bi-directional.

2. Provide non-rising stem design with stem not in contact with the fluid in the valve. Rising stem valves are not acceptable.

3. Provide valve of wafer face to face design in accordance with MSS SP-81.

4. Provide full flat faced or RF flanges with ANSI 150 flange threaded bolt hole pattern.

C. Pressure Ratings:

1. Valves Body shell pressure rating: 150 psi (1050 kPa) CWP.

D. Materials:

1. Body: Type 316 stainless steel.

2. Gate: Type 316 stainless steel.

3. Stem: Type 316 stainless steel.

4. Operator Stand: Type 316 stainless steel.

5. Seals and Scrapers: Buna-N or Viton.

E. Valves Design:

1. Provide the top gate transverse seal fully enclosed and re-packable with the valve in service under full rated pressure and without the removal of a packing gland or follower.

2. Valves with stuffing box packing gland or follower are not acceptable.

3. Provide the transverse seal capable of resealing by means of injection of packing material into the seal chamber through external ports located at a minimum of four locations to ensure even pressure and packing material distribution.

4. Provide dual scraper blades to protect the transverse seal.

a. Provide the scraper blades for a live load scraping action as the gate moves up and down.

5. Provide both faces and both edges of the gate with a surface finish of 43 micro-inch (1.09 micrometre).

6. Provide the leading edge of the gate straight or not inscribing more than a 60 degree included angle.

7. Provide the gate guided for the full length of the stroke and supported to withstand full rated shutoff pressure in either direction.

8. Provide a resilient seat in the bottom port area of the valve flush with the port area. Valves with a cavity in which flow media can collect are not acceptable.

9. Provide the valves with a resilient body seat, sealing around the edge, not the face of the gate, and replaceable and mechanically retained without the use of adhesives.

10. Provide the valves with a secondary metal seat to provide gate support and to withstand the full rated pressure in either direction.

11. Provide stem nut with valve position indication and provide threads of nut fluoropolymer coated to eliminate the need for lubricating the valve stem.

12. Leakage Rate:

    a. Provide valves with zero leakage at the full rated pressure differential in both directions.

    b. Shutoff to be tighter than ANSI class VI specification.

    c. Provide all valves with a closed lockout device.

F. Operators:

1. Manual:

    a. Valves 14-inch (350 mm) and Smaller: Handwheel requiring a maximum 40 pound (18 kg) rim pull at the valve pressure rating.

    b. Valves 16-inch (400 mm) and Larger: Provide gear operator.

        (1) Gearing: Steel with enclosed cases.

            (a) Provide spur or bevel gearing as required by valve application and orientation.

    c. Chainwheels: Provide where required as specified herein.

2. Where indicated provide Type 316 stainless steel stem extension to operating floor elevation as shown and provide the bevel gear operator with a fabricated steel floorstand and handwheel.

3. Provide electric actuators in accordance with Section 40 23 13.03.

G. Shop Testing:

1. Hydrostatically test each valve body, with water, to 1.50 times the rated working pressure for a minimum of 2 minutes.

    a. No visible leakage allowed.

2. Hydrostatically test each valve gate, with water, to 1.10 times the rated working pressure for 2 minutes. Also test each valve at the minimum pressures specified herein.

3. Bi-Directional Valves: Test the valve in each direction with the required pressure on one side of the gate and atmospheric pressure on the other and the reverse.

    a. Shutoff: ANSI class VI specification or better.

4. Provide full cycling and stroking of each valve.

a. Test for a minimum of three (3) cycles.

5. Provide 30 days' notice to the Engineer prior to the start of shop testing. The Engineer has the right to witness any or all of the testing.

2.07 ECCENTRIC PLUG VALVES:

A. Manufacturers:

1. DeZurik.

2. Val-Matic.

B. Type: Non-lubricated, eccentric.

C. Body Working Pressure:

1. Cast Iron, ASTM A126 Class B or Ductile Iron, ASTM A536, Grade 64-45-12.

a. Valves 4-inch (100 mm) through 12-inch (300 mm): 175 psi (1220 kPa).

b. Valves 14-inch (350 mm) and larger: 150 psi (1050 kPa).

2. Carbon steel: 285 psi (1990 kPa).

3. Type 316 Stainless steel: 275 psi (1920 kPa).

D. Ends:

1. Grooved: ANSI/AWWA C606 for ductile iron valves.

2. Flanged: ANSI B16.1 Class 125 pound for cast iron valves.

3. Flanged: B16.5 Class 150 pound for carbon steel and stainless steel valves.

4. Buried Valves: Mechanical joint.

E. Valve Ports:

1. Provide rectangular ported valves, circular ports are not acceptable.

2. All valves100% port area.

F. Valve Seats:

1. Coat plug with seat material specified. Bolted systems are not acceptable.

a. Seat Material:

(1) Neoprene or Buna-N synthetic rubber.

2. Provide valves with one piece coated plugs with mating seats of 90 percent, minimum, pure nickel 1/8-inch (3 mm) welded into the body of valves.

3. Provide valves with seats clamped to valve with mating seat of 90 percent, minimum, pure nickel welded to the valve body.

G. Upper and Lower Plug Journal Bearings:

1. Removable, permanently lubricated stainless steel bushings for valves 20-inch (500 mm) and smaller.

2. Bronze bearings with Type 316 stainless steel bushings for valves 24-inch (600 mm) and larger.

3. Provide grit seals for upper and lower plug shafts for all valves.

H. Stem Seals:

1. Adjustable multiple V-packing.

2. Replaceable and adjustable without valve disassembly.

3. Provide valves with two sets of packing rated for vacuum service for all pump suction isolation service and for services where a vacuum is specified and indicated.

I. Operators for Valves 4-inch (100 mm) and larger:

1. Manually Operators:

a. Gear operated with handwheels, levers are not acceptable.

b. Provide gear operators rated for bi-directional shutoff at the valve working pressure rating as specified herein.

c. Gear operators: Totally enclosed worm gear, traveling nut type is not acceptable. Provide permanently lubrication, watertight and dustproof, with adjustable open and closed stops and plug position indicator.

d. Provide all work gears designed and certified to withstand input loads up to 300-feet-pounds (407 Nm) minimum at the stops without damage.

e. Buried or submerged valves: Provide watertight gear operator with handwheel operated floorstand as shown. Gear operator to be totally enclosed and gasketed with Type 316 stainless steel hardware.

f. Chainwheels: Provide where required as specified herein.

g. Where indicated provide Type 316 stainless steel stem extension to operating floor elevation as shown and provide the bevel gear operator with a fabricated steel floorstand and handwheel.

2. Electric Motor Actuators: Provide where indicated and provide in accordance with Section 40 23 13.03.

J. 3 and 4 Way Plug Valves:

1. Provide 3 and 4 way valves with port configuration and single, double or transfer plug arrangements as indicated.

2. Manual Valves: Provide all valves with lift, turn and reseat type double handwheel gear actuators. Provide drop tight shutoff in all operating directions.

3. Provide drop tight shutoff for both manual and electrically operated valves.

4. Provide electric motor actuators where indicated. Provide in accordance with Section 40 23 13.03.

K. Glass Lining

1. Provide glass lining fused to metal base by firing entire valve to temperature above 1,400 degree F (760 degrees C) and held at temperature for sufficient time to develop smooth vitreous lining which has molecular bond with metal.

2. Lining: Provide minimum of 0.008-inch (0.2 mm) thick and withstanding instantaneous thermal shock of 350 degree F (195 degrees C) differential, without crazing, blistering, or spalling. Lining free of pinholes which expose metal.

3. Provide lining hardness of 5 to 6 on the Mohs scale, and of density 2.5 to 3.0 grams per cubic centimeter.

4. Test in accordance with ASTM C283.

L. Glass Lining:

1. Provide glass lining fused to metal base by firing entire valve to temperature above 1,400 degree F (760 degrees C) and held at temperature for sufficient time to develop smooth vitreous lining which has molecular bond with metal.

2. Lining: Provide minimum of 0.008-inch (0.2 mm) thick and withstanding instantaneous thermal shock of 350 degree F (195 degrees C) differential, without crazing, blistering, or spalling. Lining free of pinholes which expose metal.

3. Provide lining hardness of 5 to 6 on the Mohs scale, and of density 2.5 to 3.0 grams per cubic centimeter.

4. Test in accordance with ASTM C283.

M. Shop Testing:

1. Provide all plug valves tested and certified bubble tight in both directions at the full rated working pressure as specified herein.

N. Shop Painting:

1. Provide epoxy painting as specified herein.

2. Provide fusion bonded epoxy, 12 mils (305 micrometres) inside and out.

3. For valves installed in glass lined piping systems provided glass lined valves with epoxy paint coating as specified herein.

2.08 BUTTERFLY VALVES – LIQUID SERVICE (AWWA):

A. Manufacturers:

1. DeZurik.

2. Val-Matic.

3. Pratt.

B. Provide valves that conform to NSF Standard 61.

C. Provide valves conforming to AWWA Standard C504 for Rubber Seated Butterfly Valves except as modified herein.

D. Provide valves larger than 72-inch (1800 mm) in accordance with the requirements of AWWA C504.

E. Valves utilizing: Continuous rubber lining on the internal body surfaces and extending over the flanges, or a disk which sits at an angle to the axis of the pipe are acceptable.

F. Valve Bearings: Self-lubricating, nonmetallic material to effectively isolate the disc-shaft assembly from the valve body. Cast or ductile iron thrust or journal bearing surfaces are NOT acceptable.

G. Class 150B valves except as specified or indicated.

H. Valve Body: ASTM A126 Class B cast iron or ductile iron.

1. Exposed or submerged service: Flanged short body valve.

2. Buried service: Mechanical joint body.

3. Wafer, lug wafer or tapped wafer valves may be used only as specified or indicated.

I. Valve Seats:

1. Potable Water Service: Molded new natural rubber or synthetic rubber.

2. Wastewater or Sludge Service: Molded neoprene, Buna-N or other synthetic elastomer resistant to oil and grease.

3. Provide seat mounted on disc or in body.

4. Provide seats offset from shaft and field replaceable for all valves 24-inch (600 mm) and larger.

5. Provide seats mounted on disc, mechanically fastened to disc with Type 316 stainless steel hex head screws. Provide rubber seat reinforced with stainless steel retaining ring. Seats vulcanized or bonded to the disc are not acceptable.

J. Mating surfaces for valves with seat on disc: Type 316 stainless steel.

1. Provide mating surface mechanically retained in body and sealed with O-ring.

K. For valves with seats mounted on body provide the seats clamped or mechanically secured with Type 316 stainless steel fasteners.

L. Mating surfaces for valve with seat in body: Type 316 stainless steel or plasma applied nickel-chromium material containing 80 percent nickel, 20 percent chrome.

M. Plated or sprayed on mating surface material not acceptable.

N. Seat Placement:

1. If seat on disc provide disc of ASTM A126 Class B cast iron or ductile iron.

2. If seat in body, provide disc of ASTM A126 Class B cast iron, ductile iron or Type 316 stainless steel. Type 316 Stainless steel edge on cast or ductile-iron discs secured with Type 316 stainless steel threaded fasteners, heat shrunk on disc, a welded-on overlay, or a plasma applied nickel-chrome material.

O. Shaft: Type 316 stainless steel. Either one piece extending completely through disc or stub shafts inserted into valve disc stubs.

P. Shaft seal of the split-V type or O-ring type. Seal replaceable without disassembly of valve.

Q. Manual Operators:

1. Operator capable of valve operation at rated pressure with a maximum 80 lb (36 kg) pull on actuator. Operator to be self-locking.

2. Valves 8-inch (200 mm) and smaller, provide lever operator, 18-inch (450 mm) maximum length.

3. Valves 10-inch (250 mm) and larger, or where chain wheels are required, provide traveling nut operator. Provide position indicator.

4. Chainwheels: Provide where required as specified herein.

R. Buried or submerged valves: Provide gear operator with operating nut and valve box or handwheel operated floorstand as shown. Gear operator to be totally enclosed with gasketed Type 316 stainless steel covers with Type 316 stainless steel fasteners for access to valve packing.

S. Electric Motor Operator: Provide in accordance with Section 40 23 13.03.

2.09 BUTTERFLY VALVES – AERATION SERVICE:

A. Manufacturers:

1. DeZurik

2. Flowseal

3. ABZ

4. Tyco Flow Control

B. Provide valves rated for 250 degree F (121 degrees C) continuous operation and 300 degree F (149 degrees C) intermittent operation.

C. Body:

1. Wafer-lug type with full-lug body, drilled and tapped for mounting bolts design.

2. Material:

a. Type 316 stainless steel

b. ASTM A126 cast or ASTM A536 ductile iron

3. Provide to mate with 125 pound ANSI B16.1 (Class 125) flanges.

4. Wafer-lug type with full-lug body, drilled and tapped for mounting bolts.

D. Seat: Dovetail, EPDM, installed in the body with elastomer formed continuously over the ends to provide seal with mating pipe flanges.

E. Disk: Air profile design, aluminum bronze ASTM B148 Alloy 952 or Type 316 stainless steel. Provide bubble-tight shut off at 25 psi (175 kPa) working air pressure.

F. Stem: One-piece of Type 316 stainless steel with bronze or Teflon bushings and EPDM or Buna-N O rings or self-adjusting packing.

1. Disc stem connection:

a. 12-inch (300 mm) and smaller: Type 316 stainless steel torque plug.

b. 14-inch (350 mm) and larger: Type 316 stainless steel disc screws.

G. Valve Operators:

1. Manually operated valves 12-inch (300 mm) and smaller provide lever-type with 10-position lock plate and valve position indicator.

2. Manually operated valves 14-inch (350 mm) and larger provide geared-type permanently lubricated, totally enclosed operator with stops to prevent over-travel, and with valve position indicator and hand wheel or chain wheel as specified.

3. Provide chainwheel operator where required as specified herein.

4. Electric motor actuators: Provide in accordance with Section 40 23 13.03.

2.10 BUTTERFLY VALVES (NON-METALLIC):

A. Manufacturers:

1. Spears
2. ASAHI/America
3. Hayward Industrial Plastics Inc.
4. NIBCO/Chemtrol/Inc.

B. Body: PVC, ASTM D-1784, Type 1, Grade 1.

C. Disc: Polypropylene, ASTM D-2146, Type 1.

1. Provide double O-ring seals on both top and bottom trunnions, provide EPDM O-ring.
2. Provide smooth disc with no reinforcing fingers to collect debris.

D. Seat: EPDM.

1. Seat to function as body liner and formed around the valve body to act as a gasket on each valve face or non-liner type interlocked with the valve body.

E. Provide bubble-tight shut off at the rated pressure.

F. Provide so that only valve disc and seat are wetted parts.

G. Stem: One piece, Type 316 stainless steel.

1. Provide disc engaged over full length of disc.

H. Valve Ratings:

1. 1-1/2-inch (38 mm) through 10-inch (250 mm): 150 psi (1050 kPa)
2. 12-inch (300 mm) and 14-inch (350 mm): 100 psi (700 kPa)

I. Operators:

1. Manual Operators:
   a. Lever Operators: Valves 1-1/2-inch (40 mm) thru 4-inch (100 mm)
   b. Gear Operators: Valves 6-inch (150 mm) and larger.
   c. Provide chainwheel operators where required as specified herein.
2. Electric actuators: Provide in accordance with Section 40 23 13.03.

2.11 BUTTERFLY VALVES - CHEMICAL SERVICE-LINED:

A. Manufacturers:

1. Technova

2. Richter

3. Flowserve

B. Materials:

1. Body: Ductile Iron ASTM A395

2. Stem: Type 316L stainless steel

3. Liner: Virgin PTFE

4. Elastomer: Hypalon

C. Working Pressure: 150 psi (1050 kPa)

D. Body Style: Lug, 150 pound (Class 150)

E. Provide sealing system using belleville springs

F. Operator:

1. 6-inch (150 mm) and smaller: Lever handle, locking type

2. 8-inch (200 mm) and larger: Gear with handwheel

3. Electric: Provide in accordance with Section 40 23 13.03.

2.12 BUTTERFLY VALVES – HIGH PERFORMANCE:

A. Manufacturers:

1. Flowseal

2. Emerson

3. DeZurik

4. Jamesbury

B. Working Pressure Rating:

1. ANSI Class 150

2. ANSI Class 300

C. Provide bi-directional bubble tight shut-off and suitable for dead-end service with removal of downstream flange.

D. Body: Type 316 stainless steel lug design.

E. Disc: Double offset design with 360 degree uninterrupted spherical edge for sealing and constructed of Type 316 stainless steel.

F. Shaft: Provide blow out proof shaft. The shaft shall be Type 316 stainless steel and positively attached to disc with Type 316 stainless steel wedge pins.

G. Seats: PTFE with encapsulated Viton O-ring creating self-energized sealing capability.

H. Packing: Chevron design TFE to prevent external leakage out of valve neck to full ANSI hydrostatic shell test pressure.

I. Valve Operators:

1. Manual Valves:

a. Provide valves 6-inch (150 mm) and smaller with ten position latch-lock lever operators.

b. Provide valves 8-inch (200 mm) and larger with manual gear operator and handwheel.

2. Provide chainwheels where required as specified herein.

3. Electric Actuators: Provide in accordance with Section 40 23 13.03.

2.13 BUTTERFLY VALVES – DIGESTER GAS SERVICE:

A. Manufacturers:

1. Crane

2. Emerson

3. Jamesbury

4. DeZurik

B. Type: High performance, fire-safe butterfly valve.

1. Provide offset seat and eccentric shaft type, capable of sealing against full differential pressure in either direction.

2. Provide bi-directional bubble tight shut-off and suitable for dead-end service with removal of downstream flange.

C. Materials:

1. Body: Type 316 stainless steel, Lugged type, 150 pound (Class 150)

2. Disc: Type 316 stainless steel

3. Shaft: Type 316 stainless steel

4. Seat: Fire-safe type, PTFE/Inconel

D. Valve Operator:

1. Manually operated valves:

    a. Geared with handwheel.

    b. Provide chainwheels where required as specified herein.

        (1) Provide stainless steel chainwheel operator where required as specified herein.

2. Electric Actuators: Provide in accordance with Section 40 23 13.03.

2.14 BALL VALVES – GENERAL SERVICE:

A. Manufacturers:

1. Jamesbury

2. KF

3. Inline

4. Kitz

B. Valves 1/2-inch (13 mm) through 4-inch (100 mm)

1. Materials:

    a. Body and End Cap: Three piece, ASTM A351 Grade CF8M.

    b. Body Seal: PTFE.

    c. Seat: RTFE.

    d. Ball: Type 316 stainless steel.

    e. Stem: Type 316 stainless steel.

2. Pressure Rating:

    a. 1/2-inch (13 mm) through 2-inch (50 mm): 1000 psi at 100 degrees F (7000 kPa at 38 degrees C)

    b. 2-1/2-inch (65 mm) through 4-inch (100 mm): 800 psi at 100 degrees F (5600 kPa at 38 degrees C)

3. Ends:

    a. 2-inch (50 mm) and Smaller: Screwed or flanged.

    b. 3-inch (75 mm) and larger: Flanged.

C. Valves 4-inch (100 mm) through 12-inch (300 mm).

1. Materials:
    a. Body and Adaptor: Two piece, ASTM A351 Grade CF8M.
    b. Seat: TFE.
    c. Ball: Type 316 stainless steel.
    d. Stem: Type 316 stainless steel.
2. Pressure Rating: ANSI Class 150.
3. Ends: Flanged.

D. Actuators:
1. Manual:
    a. 4-inch (100 mm) and Smaller: Lever.
    b. 6-inch (150 mm) and Larger: Gear operator.
    c. Provide chainwheels where required as specified herein.
2. Electric Motor Actuators: Provide in accordance with Section 40 23 13.03.

2.15 BALL VALVES - NON-METALLIC:

A. Manufacturers:
1. Spears
2. ASAHI
3. NIBCO/Chemtrol
4. Hayward

B. Materials:
1. Body: Material as specified or indicated.
    a. PVC: ASTM D-1784, Type 1, Grade 1, Class 12454B.
    b. CPVC: ASTM D-1784, Type 4, Grade 1 with hydrostatic designs stress of 1600 psi (11.2 MPa) at 73.4 degrees F (23 degrees C).
    c. Polypropylene: ASTM D-2146, Type 1 with tensile strength of 4977 psi (24.7 MPa) at 77 degrees F (25 degrees C).
    d. PVDF: Minimum tensile strength of 5000 to 7000 psi (34.9 to 48.9 MPa) at 77 degrees F (25 degrees C).

2. Ball: Same material as valve body.

3. Seats: Teflon, concave design to absorb expansion.

   a. Triangular seat design is not acceptable.

   b. Provide viton or EPDM back up cushions to absorb expansion.

4. Seals: Viton, all Viton shall contain a minimum of 55 percent Viton.

5. Provide vented ball valves for sodium hypochlorite and caustic services.

C. Ends: Type as specified or indicated:

1. Provide ends flanged in accordance with ANSI B16.1 Class 150 lb. standard drilling.

2. True union design with integral union nuts on both ends of valve.

   a. Threads between union nuts and valve body: Provide Buttress threads to protect against pipeline expansion and water hammer stresses.

D. Machine the following to final tolerances:

1. Exterior of ball

2. Interior of socket and threaded connections

3. Teflon seat recesses

4. Stem

5. Neck I.D.

6. Both end connectors

7. Both carriers

E. Valve Port:

1. 2-inch (50 mm) and smaller valves: full port.

2. 3-inch (75 mm) and 4-inch (100 mm) valves: maximum of one pipe size reduction.

3. 6-inch (150 mm) valves: Venturi design.

F. Valve Ratings:

1. PVC: 150 psi (1050 kPa) at 120 degrees F (49 degrees C).

2. CPVC: 85 psi (595 kPa) at 175 degrees F (79 degrees C).

3. Polypropylene: 85 psi (595 kPa) at 175 degrees F (79 degrees C).

4. PVDF: 85 psi (595 kPa) at 210 degrees F (99 degrees C).

5. All valves rated for 29.92 inch (760 mm) mercury vacuum.

G. Physical Properties:

1. Tensile stress, psi (MPa); per ASTM D638 Test Method:

a. PVC: 7800 (54.4)

b. CPVC: 9200 (64.2)

c. PP: 5000 (34.9)

d. PVDF: 7800 (54.4)

2. Flexural Stress, psi (MPa); per ASTM D790 Test Method:

a. PVC: 15650 (110)

b. CPVC: 17060 (119)

c. PP: 9240 (64.5)

d. PVDF: 14930 (104)

3. Compressive Strength, psi (MPa); per ASTM D695 Test Method:

a. PVC: 14220 (99)

b. CPVC: 15650 (110)

c. PP: 9950 (69.5)

d. PVDF: 14220 (99)

4. Hardness, Rockwell R, per ASTM D785 Test Method:

a. PVC: 115

b. CPVC: 118

c. PP: 95

d. PVDF: 110

5. Water Absorption, percent, 24 hr., 1/8-inch (3 mm) thickness, per ASTM D570 Test Method:

a. PVC: 0.07 percent

b. CPVC: 0.15 percent

c. PP: 0.01 percent

d. PVDF: 0.03 percent

H. Operators:

1. Lever, with retaining screw.

2. Electric Motor Actuators:

a. Provide 120V (240V) single phase actuators in accordance with Section 40 23 13.03.

b. Enclosure:

(1) NEMA 7 explosion proof for classified areas

(2) NEMA 4 or 4X for non-classified areas.

2.16 BALL VALVES – CHEMICAL SERVICE-LINED:

A. Manufacturers:

1. Technova

2. Richter

3. Flowserve

B. Valves 1/2-inch through 4-inch:

1. Materials:

a. Body and Adaptor: Two piece, ASTM A395 ductile iron PFA lined

b. Seat Rings: PTFE

c. Ball and Stem:

(1) 1/2-inch through 2-inch: Type 316 stainless steel PFA lined.

2. Pressure Rating: 200 psi (1400 kPa).

3. Ends: Flanged

C. Actuators:

1. Manual: Provide level operator

a. Provide chainwheels where required as specified herein.

2. Electric Motor Actuators: Provide in accordance with Section 40 23 13.03.

2.17 BALL VALVES – SLUDGE SERVICE (HIGH PRESSURE):

A. Manufacturers:

1. KF Industries.
2. Jamesbury.
3. Kitz.

B. Full port trunnion mounted ball valves, conforming to API 6D Class 300.

1. Provide valves with ANSI B.16, Class V leakage allowance.

C. Working Pressure: ANSI Class 300.

D. Seats and Body Rating: 650 psi (4550 kPa).

E. Materials:

1. Body and bonnet: Stainless steel CF8M.
2. Ball and stem: Type 316 stainless steel.
3. Seat rings: Type 316 stainless steel.
4. Insert: Teflon, nylon or RTFE.
5. Retainer Seals: Grafoil/TFE O-ring.
6. Valve lining to be an approved thermally bonded coating.

F. Retainer Seals: Grafoil/TFE O-ring Operator: Geared handwheel or electric actuator as shown.

G. Actuators:

1. Manual: Provide gear operator.
   a. Provide chainwheels where required as specified herein.
2. Provide electric motor actuators in accordance with Section 40 23 13.03.

2.18 BALL VALVES – AWWA – METAL SEATED:

A. Manufacturers:

1. DeZurik
2. Armacon
3. Val-Matic

B. Type: AWWA Ball Valves:

1. Provide the main valve with a full, circular, unobstructed waterway.

    a. Trunnion mounted.

    b. Metal-to-metal seated in complete conformance with the requirements of AWWA C507, latest revision.

2. Pressure Class 150/250 and consist of a main valve assembly and a motor actuator, completely assembled, tested and ready for field installation and wiring.

C. Body:

1. Provide valves with valve body consisting of four (4) components: two end pieces, through bolted and O-ring sealed against two center sections bolted together and O-ring sealed.

2. Material: Ductile iron ASTM A536 Grade 65-45-12.

3. Provide the end pieces with ANSI B16.1 Class 150/250 flanges with a true, 100 percent full circular port opening equal to the nominal size of the valve.

4. Provide the two center sections with integrally cast bronze bushed trunnions.

    a. Provide one center section for rigid mounting and support of the valve operating mechanism without the need for additional support.

    b. Provide the other section for a mounting pad to support the weight of the valve.

    c. Provide a minimum shell thickness of all four sections in accordance with Table 3 of AWWA C507, latest edition.

D. Body Seat:

1. Provide a single fixed seat of Alloy 400 Monel located on the pump side end piece and retained in the end piece only by a mechanical means.

2. Provide a spherically generated the seating surface on an eccentric seating axis eliminating seat contact during rotation.

E. Operators:

1. Manually Valve:

    a. Provide totally enclosed gear operators in a permanently lubrication, watertight and dustproof enclosure, with adjustable open and closed stops and ball position indicator.

    b. Provide chainwheels where required as specified herein.

2. Electric Actuators: Provide in accordance with Section 40 23 13.03.

2.19 BALL VALVES – CHEMICAL SERVICE – TITANIUM:

A. Manufacturers:

1. TBV.

2. Sharpe.

B. Ball valves shall have one piece bodies with Class 150 integral raised face flanges. Multiple piece body valves are not acceptable.

C. Valve body, ball, stem and seat retainer: Titanium.

D. Seats, seals and packing: PTFE.

E. Provide an integral fugitive emission bonnet to preclude the potential of stem leakage.

F. Operator:

1. Manual: Lever

2.20 BALL VALVES – DIGESTER GAS SERVICE:

A. Manufacturers:

1. Kitz.

2. KF.

3. Jamesbury.

B. Full port trunnion mounted ball valves, conforming to API 6D Class 150.

1. Provide valves with ANSI B.16, Class V leakage allowance.

2. Fire-Safe design.

3. Suitable for dead end service, zero leakage

4. Ends: Flanged.

C. Working Pressure: ANSI Class 150.

D. Materials:

1. Body and bonnet: Stainless steel CF8M.

2. Ball and stem: Type 316 stainless steel.

3. Seat rings: Type 316 stainless steel.

4. Insert: Teflon.

5. Retainer Seals: Grafoil/TFE O-ring.

E. Retainer Seals: Grafoil/TFE O-ring.

F. Operator: Geared handwheel or electric actuator as shown. Provide electric motor actuators in accordance with Section 40 23 13.03.

G. Purge Ports: Provide valves with two (2) 3/4-inch (19 mm) threaded purge ports and Type 316 stainless steel threaded ball valves with Teflon seats. Provide Type 316 stainless steel caps on each purge valve.

2.21 BALL VALVES – V-PORT

A. Manufacturers:

1. DeZurik or approved equal

B. Accuracy for valve, actuator and positioner assembly shall be 0.5% or better with a resolution of 200 or more discrete positions over 90° range of operation. Each valve, actuator and positioner shall be assembled, adjusted, and tested as a unit by the valve manufacturer or an authorized automation facility.

C. Shop Testing shall be performed on each valve in accordance with the procedure specified in the latest version of AWWA C507. Test results shall be tied to the valve serial number. In addition, the valve should be tested at the following percent openings:

1. 1%

2. 5%

3. 10%

4. 20%

5. 50%

D. Shafts shall be blowout proof and constructed of 2205 duplex stainless steel (ASTM A276) or 17-4 pH condition H900 (ASTM A564) or higher alloy. Shaft to Ball connection shall be splined and have a torque screw to eliminate backlash (deadband).

E. Actuator connection shall be a clamped design to rigidly hold the valve shaft. The use of double-D or keyed connections shall not be allowed.

F. V-Port ball design shall be optimized to meet or exceed 200:1 rangeability. Back of ball must be streamlined to transition flow and minimize erosion. Hollow ball designs shall not be allowed. Seat to ball interface shall be self-aligning and controlled without the use of shims or threaded components.

G. Valve Seats shall be interchangeable in the same body.

1. Flexible Metal seat used for fibrous media provides shut-off to ANSI/FCI 70-2 Class IV.

H. Bearings shall be 317 stainless steel wire mesh reinforced PTFE or solid metal with optional seal.

I. Packing shall be multiple v-ring PTFE, shall permit inspection, adjustment or complete replacement of packing without disturbing any part of the valve or actuator assembly except the packing follower.

J. Bodies shall be constructed of carbon steel (ASTM A216). The valve body shall be one piece, integral cast flanged. Face-to-face dimensions shall meet ASME B16.10, ISO 5752 (PN10/16) and EN 558-1 or ANSI/ISA 75.04 and IEC 534-3-2.

K. Two Year Warranty shall be provided for all valves and actuators.

2.22 PINCH VALVES:

A. Manufacturers:

1. Flowrox.

2. Onyx.

3. RF Valves

4. NO OTHER MANUFACTURERS ARE ACCEPTABLE

B. Type: Enclosed full metal sealed body, mechanical pinch type.

1. Valves to be manufacturer's standard cataloged product and modified to meet the specification.

2. Valve manufacturer and sleeve manufacturer must be ISO 9000 certified. Provide certification and quality system plan.

3. Provide a listing of contacts and telephone numbers of a minimum of three (3) installations with valves of the same type and size and in the same service as specified operating for not less than three (3) years.

C. Valve Body:

1. Provide a split gasketed valve body. Valve bodies must be split perpendicular to the valve stem.

2. Body working pressure rating: 150 psi (1050 kPa).

3. The upper and lower body sections must be interchangeable with all valves of the same size, design and model number.

4. Provide valve with a fugitive emissions package that includes stem and body seals to provide secondary containment of the fluid in the valve. Provide an additional secondary containment system to isolate the stem from the liquid in the valve body in the event of sleeve failure.

a. Provide a 2-inch (50 mm) pressure gauge and PVC protective diaphragm for indication of sleeve failure.

b. Gauge piping: Type 316L schedule 40 stainless steel.

5. Ends: Flanged, drilled and tapped to Class 150 ANSI standard.

6. Prime and finish paint interior and exterior of valve body and actuator assembly with two 60 micron coats of epoxy primer and one 60 micron coat of epoxy finish coat or equal.

7. Test the body and the fugitive emissions system at the specified working pressure without the sleeve installed.

D. Sleeves:

1. Fabricate sleeve of one-piece construction.

2. Provide inner protective lining of nitrile rubber elastomer with a maximum IRH hardness of 40 to 80.

3. Reinforce sleeve with Kevlar cord.

4. Provide positive opening tabs attached to pinch bar mechanism. Attach with Type 316 stainless steel hardware.

5. Sleeve working pressure rating: 150 psi (1050 kPa). Provide sleeves designed with a minimum safety factor of 3 above the specified pressure rating.

6. Test sleeves at the specified pressure rating independent of the valve body.

7. The sleeve shall be the only part of the valve in contact with the process fluid and rated for the pressure and service specified and indicated.

8. Port area: 100 percent of the pipe diameter through the entire valve.

9. Sleeves to be suitable for the service specified. Provide evidence that the sleeve material has been used successfully in the same service conditions as specified for a minimum of five (5) years. The material will not be acceptable if there have been failures within three (3) years of start of operation.

E. Operating Mechanism:

1. Provide double acting type that pinches the sleeve on the centerline equally from two sides. Single acting mechanisms are not acceptable.

2. Provide lubrication fittings.

3. Provide mechanical stops to prevent over pinching of the sleeve.

4. Manual Valves:

a. Valves 6-inch (150 mm) and smaller: Handwheel.

b. Provide gear operators for valves 8-inch (200 mm) and larger and for valves located 6 feet-6 inches (2.0 m) above the operating level.

c. Provide chainwheels where required as specified herein.

5. Provide electric motor actuators where indicated and as specified in Section 40 23 13.03.

6. Mechanism must be capable of frequent opening and closing cycles.

7. Provide the word “SHUT” and a direction arrow for all handwheels.

F. Materials:

1. Body: ASTM A48 Class 30 cast iron.

2. Sleeve: Material as recommended by the valve manufacturer for the service specified and indicated.

3. Closing mechanism and internal guides:

a. Type 316 stainless steel.

b. Pinch Bars: Type 316 stainless steel or ASTM A535-80 Class 65-45-12 ductile iron epoxy coated

4. Valve stem: Type 316L stainless steel.

5. Thrust bearing: brass.

6. Valve position indicator: Type 316L stainless steel.

7. Bushings: Polyethylene RCH 1000.

G. Shop Testing:

1. Provide certified test data for the following or conduct tests:

a. Provide tests by an independent company.

b. Test valves for a minimum of 3,700,000 pressure changes from 0 to 106 psi (740 kPa).

c. For valves to be used for hose pumps test valves mounted on a hose pump suction nozzle. Close the valve creating a full vacuum with pump running for 24 hours and test valve for an additional 24 hours slightly open to create 50 percent vacuum. After these two tests, test valve fully closed to determine if full vacuum can be reached and contained once the pump is stopped. Test two valves of each size.

d. Provide a written report with test procedure and results.

2. Hydrostatically test valve body without sleeve to 150 psi (1050 kPa), for two valves of each size.

3. Hydrostatically test valve sleeve to 150 psi (1050 kPa), and test at 3:1 safety factor for two valves of each size.

4. Test valve mechanisms with atmospheric on one side of valve and pressures from 0 to 150 psi (0 to 1050 kPa) on other side.

5. Hydrostatic tests and results must meet ANSI B.16.104 Class V shutoff.

2.23 PINCH VALVES – AIR OPERATED:

A. Manufacturers:

1. Onyx.

2. RF Valves

B. Pneumatically operated jacket type valves.

C. Provide 100 percent port area through the entire valve length.

D. Body:

1. Cast iron ASTM A126 Class 35.

2. Split type with tapped pressure connections on the top and bottom of the valve. One connection for compressed air and one for a drain.

a. Compressed Air Inlet:

(1) Valves 2-1/2-inch (65 mm) and Smaller: 1/4-inch (6 mm).

(2) Valves 3-inch (80 mm) through 5-inch (125 mm): 1/2-inch (13 mm).

(3) Valves 6-inch (150 mm) and 8-inch (200 mm): 3/4-inch (19 mm).

(4) Valves 10-inch (250 mm) and 12-inch (300 mm): 1-inch (25 mm).

b. Drain: 1/4-inch (6 mm) with bronze plug.

3. Ends: Flanged.

E. Sleeve: Neoprene, Nylon reinforced with flanged ends, double thickness.

F. Controls:

1. Provide a 4 way 1 coil solenoid valve with manual override. Provide solenoid valve as specified herein

a. Enclosure: NEMA 4X for non-classified areas and NEMA 7 for classified areas.

2. Provide an air pressure regulator with 0 to 150 psi (0 to 1050 kPa) gauge

2.24 PINCH VALVES – NON METALLIC:

A. Manufacturers:

1. Flowrox.

2. NO OTHER MANUFACTURERS ARE ACCEPTABLE.

B. Size: 2-inch (50 mm) through 6-inch (150 mm).

C. Type: Fully Enclosed body, mechanical pinch type.

1. Valves to be manufacturer's standard cataloged product and modified to meet the specification.

2. Valve manufacturer and sleeve manufacturer must be ISO 9000 certified. Provide certification and quality system plan.

3. Provide a listing of contacts and telephone numbers of a minimum of three (3) installations with valves of the same type and size and in the same service as specified operating for not less than three (3) years.

D. Valve Body:

1. Provide a split gasketed valve body.

2. Body working pressure rating: 150 psi (1050 kPa).

3. The body sections must be interchangeable with all valves of the same size, design and model number.

4. Ends: Flanged, drilled and tapped to Class 150 ANSI standard.

E. Sleeves:

1. Fabricate sleeve of one-piece construction.

2. Provide inner protective lining of nitrile rubber elastomer with a maximum IRH hardness of 40 to 80.

3. Reinforce sleeve with Kevlar cord.

4. Provide positive opening tabs attached to pinch bar mechanism. Attach with Type 316 stainless steel hardware.

5. Sleeve working pressure rating: 150 psi (1050 kPa). Provide sleeves designed with a minimum safety factor of 3 above the specified pressure rating.

6. Test sleeves at the specified pressure rating independent of the valve body.

7. The sleeve shall be the only part of the valve in contact with the process fluid and rated for the pressure and service specified and indicated.

8. Port area: 100 percent of the pipe diameter through the entire valve.

9. Sleeves to be suitable for the service specified. Provide evidence that the sleeve material has been used successfully in the same service conditions as specified for a minimum of five (5) years. The material will not be acceptable if there have been failures within three (3) years of start of operation.

F. Operating Mechanism:

1. Provide double acting type that pinches the sleeve on the centerline equally from two sides. Single acting mechanisms are not acceptable.

2. Provide lubrication fittings.

3. Provide mechanical stops to prevent over pinching of the sleeve.

4. Provide handwheel operators.

G. Materials:

1. Body: Polyamide blend.

2. Sleeve: Material as recommended by the valve manufacturer for the service specified and indicated.

3. Closing mechanism and internal guides: Type 316 stainless steel.

4. Valve stem: Type 316L stainless steel.

5. Thrust bearing: brass.

6. Valve position indicator: Type 316L stainless steel.

7. Bushings: Polyethylene RCH 1000.

2.25 DIAPHRAGM VALVES (METALLIC/LINED TYPE):

A. Weir Type.

B. Manufacturers:

1. ITT Engineered Valves.

2. Saunders Valve.

3. McCanna.

C. Materials:

1. Body:

a. Ductile Iron ASTM A395 GR60-40-18 or Cast Iron ASTM A126 Class B.

b. Provide Kynar Coated Flanges, Faced and Drilled in accordance with Class 125 ANSI Standard.

2. Lining: Kynar.

3. Diaphragm: Teflon.

D. Operators:

1. Provide handwheel operators for manually operated valves.
2. Provide pneumatic cylinder operators for automatically operated valves.
    a. Air to open, spring to close to provide failsafe closure.
    b. Position indicator.
    c. Manual handwheel.
    d. Contacts for position signals.
    e. Air Supply: 80 psi (560 kPa).

2.26 SWING CHECK VALVES – 3-INCH (75 MM) AND SMALLER:

A. Valves 1/2-inch (13 mm) to 2-inch (50 mm):
1. Working Pressure: 200 psi (1400 kPa)
2. Type: Y-Pattern
3. Ends: Threaded ASME 1.20.1
4. Materials:
    a. Body, Cap Disc and Hinge Arm: ASTM A351 CF8M
    b. Hinge Pin, Disc Nut Disc Washer and Plug: ASTM A276 Type 316 stainless steel
    c. Seal and Gaskets: PTFE

B. Valves 1/2-inch (13 mm) to 3-inch (75 mm):
1. Working Pressure: ANSI Class 150
2. Type: Swing check with bolted cover
3. Ends:
    a. 1/2-inch (13 mm) through 2-inch (50 mm): Threaded ASME 1.20.1
    b. 1/2-inch (13 mm) thru 3-inch (75 mm): Flanged
4. Materials:
    a. Body, Cap Disc and Hinge Arm: ASTM A351 CF8M
    b. Hinge Pin and Plug: ASTM A276 Type 316 stainless steel
    c. Plug Seals and Gaskets: PTFE

2.27 TILTING DISC CHECK VALVES:

A. Manufacturers:

1. Val-Matic.
2. Crispin.
3. DeZurik-APCO.

B. Materials:

1. Body: Cast Iron ASTM A48 Class 30.
2. Disc:
   a. Valves 24-inch (600 mm) and smaller: Cast Iron ASTM A48 Class 30 or solid, one piece CDA #C83600 bronze disc with no attached disc ring.
   b. Valves 30-inch (750 mm) and larger ASTM A536 Class 65-45-12 ductile iron.
3. Seat Ring: Cast Aluminum Bronze ASTM B271 Alloy 954; BHN 150 or CDA #C83600 bronze.
4. Disc Ring: Cast Aluminum Bronze ASTM B271 Alloy 955; BHN 190 or CDA #C83600 bronze.
5. Pivot Pin: Aluminum Bronze ASTM B505, Alloy 955; BHN 195 or Type 303 stainless steel.
6. Pivot Pin Bushing: Aluminum Bronze ASTM B505 Alloy 954; BHN 170.

C. Body:

1. Two piece construction bolted together at the seat with the seat at approximately a 55 degree angle.
2. Inlet body section to contain seat ring and outlet body section to contain two pivot trunnions about which the disc rotates.
3. Provide an inspection port each body half. Locate inspection port in inlet body section on bottom of valve and on top of valve on outlet section.
4. Area through valve must equal to full pipe area.
   a. Area through seat must equal 1.4 times the area through the inlet and outlet.
5. Provide an indicator to visually show valve disc position at all times.
6. Ends: Flanged, faced and drilled in accordance with Class 125 ANSI B16.1.

D. Bottom Mounted Snubber:

1. Self-contained oil filled hydraulically operated.

2. Provide control rate of closure over final 10 percent of disc movement.

3. Provide hydraulic flow control valve to adjust closing speed.

4. Provide snubber with an air gap between pumped product and snubber cylinder.

E. Shop Test:

1. Provide witness test on one valve and non-witnessed test on all others.

2. Conduct 250,000 cycle test with resulting leakage rate not to exceed 75 percent of allowable rate for new valves in accordance with AWWA and MSS standards.

2.28 BALL CHECK VALVES – CHEMICAL SERVICE – LINED:

A. Manufacturers:

1. Richter.

2. Technova.

3. Flowserve.

B. Sizes: 1/2-inch (13 mm) through 6-inch (150 mm).

C. Body: Split type, epoxy coated Ductile Iron ASTM A395.

D. Lining: PFA or FEP suitable for the service conditions specified and indicated. Lining to cover inner valve body and flange seating surface.

E. Ball: Solid or hollow to suit the service conditions specified and indicated.

F. Bolting: Type 316 Stainless Steel.

G. Pressure Rating: 150 psi (1050 kPa) for solid ball type valves and 43.5 psi (305 kPa) for hollow ball type valves.

H. Ends: Flanged ANSI B-16.1 Class 150.

I. Provide valves suitable for vertical or horizontal installation.

J. Vertical installation requires no more than 0.5 psi (3.5 kPa) to unseat the valve.

K. Horizontal installation requires no more than 14.5 psi (102 kPa) backpressure for solid balls and 7.25 psi (50 kPa) backpressure for hollow balls.

2.29 BALL CHECK VALVES – METALLIC:

A. Manufacturers:

1. VAG-Golden Anderson.

2. Flomatic.

B. Body: Cast Iron ASTM A126 Class B.

C. Cover: Cast Iron ASTM A126 Class B.

D. Ball: Vulcanized Buna-N with hollow metal core.

E. Bolting: Carbon Steel.

F. Pressure Rating: 150 psi (1050 kPa).

G. Ends: Flanged ANSI B-16.1 Class 125.

2.30 BALL CHECK VALVES -NON-METALLIC:

A. Manufacturers:

1. Spears.

2. ASAHI.

3. NIBCO/Chemtrol.

4. Hayward.

B. Materials:

1. Body: Material as specified or indicated.

a. PVC: ASTM D-1784, Type 1, Grade 1, Class 12454B.

b. CPVC: ASTM D-1784, Type 4, Grade 1 with hydrostatic design stress of 1600 psi (11.2 MPa) at 73.4 degrees F (23 degrees C).

c. Polypropylene: ASTM D-2146, Type 1 with tensile strength of 4977 psi (34.7 kPa) at 77 degrees F (25 degrees C).

d. PVDF: Minimum tensile strength of 5000 to 7000 psi (34.9 to 48.9 kPa) at 77 degrees F (25 degrees C).

2. Ball: Same material as valve body.

3. Seats: Teflon, concave design to absorb expansion.

a. Triangular seat design is not acceptable.

b. Provide Viton or EPDM back up cushions to absorb expansion.

4. Seals: Viton, all Viton to contain a minimum of 55 percent Viton.

C. Ends: Type as specified or indicated.

1. Provide ends flanged in accordance with ANSI B16.1 Class 150 standard drilling.

2. True union design with integral union nuts on both ends of valve.

   a. Provide O-rings suitable for the service specified and indicated.

   b. Threads between union nuts and valve body: Deep molded square ACME threads to protect against pipeline expansion and water hammer stresses.

2.31 RUBBER FLAPPER CHECK VALVES:

A. Manufacturers:

1. Val-Matic.

2. DeZurik APCO.

3. Crispin.

B. Materials:

1. Body and Cover: Ductile Iron ASTM A536 Grade 65-42-12.

   a. Valves 8-inch (200 mm) and Smaller: ASTM A351 CF8M.

2. Rubber Flapper: Buna N 70 Durometer ASTM 2000-BG encapsulating an ASTM A36 steel plate.

3. Hinge Pin: AISI 1018.

C. Provide valves with a full pipe size flow area.

D. Provide valves 4-inch (100 mm) and larger capable of passing a 3-inch (76 mm) sphere.

E. Provide a threaded connection with bronze plug on cover and on the bottom of the valve.

F. Working Pressure:

1. 2-inch (50 mm) through 24-inch (600 mm): 250 psi (1750 kPa).

2. 30-inch (750 mm) and 36-inch (900 mm): 150 psi (1050 kPa).

G. Ends: Flanged ANSI B16.1, Class 150.

H. Provide seating surface at a 45 degree angle such that the flapper travels a maximum of 35 degrees from full closed to full open position.

I. Provide valve with cover designed for removal of the valve internals without removing the valve from the pipeline.

J. Position Indicator:

1. Provide a mechanical indicator to provide disc position for valves 4-inch (100 mm) and larger.

2. Provide the indication with continuous contact with the disc.

3. Provide a limit switch for remote indication of valve position. Provide limit switches in accordance with Section 40 90 00.

K. Backflow Device:

1. Provide a screw type rising stem backflow device located on the bottom of the check valves.

2. Provide a stainless steel T-handle device with bronzed bushings.

2.32 ANGLE BODY RUBBER FLAPPER SWING CHECK VALVES:

A. Manufacturers:

1. Flomatic Model 78A.

B. Angle pattern valve with net flow area not less than the area of a circle of the same nominal pipe size.

1. Vertical mounting with either up-flow or down-flow pattern through the valve.

2. Dimensions equal to a standard ductile iron short radius 90 degree bend.

C. Full port, unobstructed flow pattern.

D. Provide a stop so that when the valve is in the full open position the flapper bears against the stop. Locate the stop so that the flapper will not twist or bend with flow through the valve.

E. Provide valves with the flapper assembly seated under the valve body cover in a way that allows flexing of the flapper from closed to full open under flow through the valve.

F. Provide valve with cover designed for removal of the valve internals without removing the valve from the pipeline.

G. Materials:

1. Body: Ductile iron, flanged with ANSI B16.1 Class 150 drilling.

2. Cover: Ductile iron

3. Cover Gasket: Buna-N

4. Body Hardware: Type 316 stainless steel

5. Flapper: Neoprene

6. Flapper Plate, Valves 10 inch (250 mm) and larger: ASTM A126 Cast Iron

7. Flapper Ring, Valves 10 inch (250 mm) and larger: ASTM A126 Cast Iron

8. Internal Hardware: Type 316 stainless steel

H. Non-Shock Working Pressure:

1. Valves 3 inch (75 mm) through 12 inch (300 mm): 175 psi (1225 kPa)

2. Valves 14 inch (350 mm): 150 psi (1050 kPa)

2.33 SPLIT DISC CHECK VALVES – AERATION SERVICE:

A. Manufacturers:

1. Marlin

B. Working Pressure: 150 psi (1050 kPa).

C. Body Type: Lug, wafer types are not acceptable

D. Materials:

1. Valve Body: Type 316 stainless steel ASTM A351 CF8M.

2. Valve Disc: Type 316 stainless steel ASTM A351 Grade CF8M.

3. Seat: Viton-B, suitable for temperatures to 400 degrees F (204 degrees C).

4. Springs: Inconel 600, suitable for temperatures to 600 degrees F (315 degrees C).

2.34 FOOT VALVES:

A. Manufacturers:

1. Val-Matic.

2. VAG-Golden-Anderson.

3. DeZurik/APCO.

B. Type: Full flow globe style:

1. Provide valve with center guided disc.

2. Provide guide bushing and threaded bushing retainer.

3. Provide valve disc concave to the direction of flow.

4. Provide valve disc and seat with a 32 mico-inch (0.8 micron) finish or better and provide a Buna-N seal on the seat.

5. Provide seal design to provide both metal to metal and metal to Buna-N seal.

6. Provide screen with a minimum flow through area of 110 percent of pipe area.

C. Ends: Flanged, ANSI B16.1 Class 125.

D. Materials:

1. Body and Flanges: ASTM A126 Class B cast iron.

2. Seat Ring: ASTM B584 Alloy C83600 cast bronze.

3. Seat Retainer: Type 316 stainless steel.

4. Hardware: Type 316 stainless steel.

5. Bushing and Bushing Retainer: Bronze.

6. Seal: Buna-N.

7. Plug: ASTM B584 Alloy C83600 cast bronze.

8. Basket Screen: Type 316 stainless steel.

E. Service Conditions:

1. Refer to Valve Schedule

2.35 ELECTRIC MOTOR OPERATED PUMP CHECK VALVES:

A. Manufacturer:

1. VAG-Golden Anderson.

B. Valve Type: Wye or Elbow-pattern valve as indicated, self-cleaning and with a net flow area through it no less than area of its nominal pipe size.

C. Performance:

1. Valve Service: Raw Unscreened Wastewater.

2. Flow Rate:

a. Design: 2,100 gpm

b. Minimum: 1500 gpm

c. Maximum: 3,000 gpm

3. Pressure:

a. Pump Shutoff Pressure: 240 psi

(1) Contractor shall coordinate valve rating with pumps selected.

b. Operating Pressure: 168 psi

4. Valve Size: 12-inch

5. Cv: Not less than 2,900.

D. Body:

1. Ductile iron ASTM A536 Grade 65-45-12.

2. Provide body with integral flanges faced and drilled to ANSI B16.1 Class 150/250.

3. Provide a replaceable Type 316 stainless steel seat and a clean out/inspection port near the valve seat.

E. Materials:

1. Valve Disc: Ductile iron A536 Grade 65-45-12.

2. Valve Seat: Renewable, resilient seat of ultra high molecular weight polyethylene and retained by a Type 316 stainless steel follower ring and Type 316 stainless steel screws.

3. Valve Stem: Type 316 stainless steel, guided in a bronze bushing retained in the valve cover and sealed where it passes through the body by a pressure-actuated seal.

F. Operation:

1. Provide the valve with a spring-assisted integral check valve that closes upon pressure reversal and independently of the actuator in order to prevent back flow through the pump.

2. Provide an electric actuator in accordance with Section 40 23 13.03.

a. Multi-turn, non-modulating electric motor actuator.

b. Provided an integral “stepping mode” to extend the operating time over any portion of the valve‘s opening and closing stroke.

c. Provide the start/end and the on/off pulse time field adjustable

2.36 DUCK BILL CHECK VALVES:

A. Manufacturers:

1. Proco

2. Tideflex

3. Flowrox

B. Service:

1. Process Drains:

a. Material: EPDM.

(1) Provide flanged or slip on type valve with Type 316 stainless steel clamps as indicated.

(2) Provide inline type with flanged connection or insertable as indicated.

2.37 FLAP VALVES:

A. Manufacturers:

1. Hydro Gate.

B. Type:

1. Hinged, single flap type designed to close tight whenever downstream pressure exceeds upstream pressure.

C. Materials:

1. Body and Flap: Cast iron, ASTM A126-B.

2. Seat: Bronze, ASTM B21-CA464 or B133-CA110 or neoprene as shown or specified.

3. Hinge Arms: Bronze, ASTM B584-CA865.

4. Hinge Pins: Designed in double shear, silicon bronze ASTM B98-CA655 or Type 316 stainless steel.

D. Fabrication:

1. Flap: Spherical dished design, size to withstand maximum operating loads.

2. Hinge Arm: Provide two pivot points. Provide an adjustable lower pivot with limited rotation and a threaded upper hinge post to adjust flap valve sensitivity.

a. Provide a lubrication fitting for each pivot.

3. Provide double nut connections, cotter pins are not acceptable.

4. Ends: Class 125 ANSI standard drilling.

E. Gravity Flow Flap Valves:

1. Provide bronze seats pneumatically impacted into dove-tail grooves machined to a 63 micro-inch (1.6 micron) finish.

F. Pumped Flow Flap Valves:

1. Resilient Seat: Neoprene or Buna-N, bonded in a groove machined in the body to provide contact surface for the seat machined in the flap.

2. Provide a steel leaf-spring.

a. Provide spring attached to body and extend over the flap to provide a safety limit of travel.

b. Provide a neoprene or Buna-N pad on the spring contact area.

G. Wall Thimbles:

1. Material: Cast Iron, ASTM A126.

2. One piece construction, of section to withstand all operational and installation stresses.

3. Provide a water stop cast around the periphery of the thimble.

4. Provide a machined front flange and provide tapped holes for the flap valve attaching studs.

5. Provide a permanent gasket of uniform thickness or mastic between the flap valve and the wall thimble.

2.38 FLEXIBLE FLAP VALVES:

A. Manufacturers:

1. Whipps

2. Hydro Gate.

B. Provide flap valves designed and fabricated to open with a maximum differential head of 6 inches (150 mm) across the valve.

1. Provide the valve with a nominal seat angle of 3 degree from the vertical, range 2 to 5 degrees, designed for the service conditions specified and indicated.

2. Provide the flexible flap valves to fit into the space indicated.

3. Provide the size and number of flaps per valve as shown.

C. Flap Valve Frame and Supports:

1. Material: Type 316L stainless steel, minimum thickness 1/2-inch (13 mm).

2. Provide continuous welds for frame and supports.

3. Frame shall consist of a body, front flange and back flange.

4. Back Flange: Flat and suitable for mounting around a concrete opening of the size indicated and specified with 8 inches (200 mm) of space around the opening for bolting.

5. Front Flange: Fabricate at an angle as specified.

6. Bolt the flexible covers to the frame with Type 316 stainless steel hardware.

7. Provide a minimum of two Type 316 stainless steel lifting eyes welded to the top of the frame.

8. Provide a neoprene lip type seal mounted along the perimeter of all openings of the frame and attach with Type 316 stainless steel hardware.

D. Flap Valve Covers:

1. Neoprene, minimum 1-1/4 inch (32 mm) thick with a durometer of 50 to 65.

2. Horizontally reinforce the covers with Type 316L stainless steel angles or formed shapes. Provide the reinforcing on the downstream side of the flap valve with a corresponding Type 316L stainless steel bar or flat plate on the upstream side of the flap valve. Bolt the reinforcing and the bars together with Type 316 stainless steel through bolts. Provide seals for the holes in the neoprene covers.

3. Reinforcing minimum thickness: 3/8-inch (10 mm) with a maximum deflection of 1/4-inch (6 mm) with the full design seating head on the downstream side of the flap valve. The deflection calculations shall not include the backing bar or plate.

4. Provide the covers attached to the frame with Type 316L stainless steel bars and Type 316 stainless steel hardware and bolted to the frame at the top of each opening.

5. Provide a Type 316L lifting handle welded to the bottom reinforcement of each cover to allow each flap valve cover to be opened and closed manually.

2.39 MUD VALVES:

A. Manufacturers:

1. Trumbull.

B. Type: Non-rising stem with plug guided through the entire length of travel.

1. One piece with an integral thrust collar and be cast or machined.

2. Resilient seated.

C. Minimum Stem Diameter:

Valve Size inch (mm)	Minimum Stem Diameter inch (mm)
4 (100)	1-3/16 (30)
6 (150)	1-3/16 (30)
8 (200)	1-7/16 (37)
10 (250)	1-7/16 (37)
12 (300)	1-7/16 (37)
16 (400)	1-1/2 (38)

D. Pressure Capability: 100 psi (700 kPa) unseating.

E. Provide valves capable of withstanding a minimum input torque of 490 foot pounds (664 Nm) without damage to the valve.

F. Provide the valve to leak a maximum of one quart per hour, when the valve is closed to a stem torque of 35 foot pounds (47.45 Nm).

1. Provide leakage and torque testing with a report from an independent test laboratory.

G. Provide valves with stem coupled to the extension stem with a Type 316 stainless steel machined coupling or a cast Type 316 stainless steel 2-n (50 mm) square operating nut and retained with a 1/4-n (6 mm) Type 316 stainless steel spring pin.

1. Stainless steel welded components are not acceptable for this connection or to the valve stem.

2. Provide stems retained with fasteners assembled through holes drilled in the valve guide and yoke and retained with hex nuts. Valve designs which retain the valve stem by threading stainless screws into tapped holes are not acceptable.

3. Provide stems with a permanently bonded coating to prevent galling with other stainless components.

a. Provide the coating safe for potable water use and capable of enduring a minimum of 15,000 open-close cycles without galling.

b. Provide cycle testing report from an independent test laboratory.

4. Provide adjustable stem guides with support spacing not to exceed 7 feet (2.1 metres).

H. Provide the base flange drilled in accordance with ANSI 125 pound standard with a minimum thickness of 3/4-inch (19 mm).

1. Machine the base flange seating surface.

I. Position Indication:

1. Provide either a Position Indicator or Indicating Floorstand as shown.

2. Provide indication of the position of the mud valves, from fully open to fully closed, visible at the operating level.

3. Position Indicator:

a. Where there is a floor directly over the valve and extension stem, install the position indicator in a cast iron floor adapter. Provide the adapter with a bronze bushing to support and center the extension stem.

b. Where a floor is not directly over the valve and extension stem, support the position indicators, bench stands and floorstands by a wall bracket mounted to the side wall.

4. Position Indicator:

a. Planetary gear design.

b. Provide the sun gear, planet gear, ring gears and scale plate constructed of Delrin.

c. Hardware: Type 316 stainless steel.

d. Housings of carbon steel or aluminum are not acceptable.

e. Provide the top scale plate with recessed markings representing the number of turns, contain the word “Closed”, and a directional arrow.

f. Provide the “open” line marked on a transparent polycarbonate window, which can be field adjusted for the number of turns of each valve size.

g. Provide the position of the adjustable “open” window secured to the top surface of the scale plate.

J. Materials:

1. Body flange: Type 316 cast stainless steel.

2. Yoke: Type 316 cast stainless steel.

3. Guides: Type 316 cast stainless steel.

4. Gate: Type 316 cast stainless steel.

5. After machining, passivate all castings in accordance with ASTM A-380.

6. Valves including components welded from stainless steel are not acceptable.

7. Resilient Seat: Viton and mechanically retained.

8. Hardware: Type 316 stainless steel.

9. Stem: Type 316 stainless steel.

10. Extension Stem: Type 316 stainless steel, either schedule 40 pipe or solid round bar.

11. Top Nut and Bottom Couplings: Cast or machined from Type 316 stainless steel.

12. Stem guides and supports: Type 316 cast stainless steel.

13. Stem Guide Bushings: Bronze, NSF 61.

14. Seat: Viton O-rings.

15. Hardware: Type 316 stainless steel.

K. Operator:

1. Provide a Type 316 stainless steel handwheel operated floor stand or benchstand as shown and as specified herein.

2. Provide a 2-inch (50 mm) square operating nut with floor box and cover.

3. Provide an electric actuator as specified in Section 40 23 13.03.

2.40 GLOBE VALVES 3-INCH (75 MM) AND SMALLER:

A. Valves 1/2-inch (13 mm) to 2-inch (50 mm):

1. Working Pressure: 200 psi. (1400 kPa)

2. Rising stem with plug type disc.

3. Ends: Threaded ASME 1.20.1.

4. Materials:

a. Body and Bonnet: ASTM A351 CF8M.

b. Disc, Stem and Gland: ASTM A276 Type 316 stainless steel.

c. Packing and Gaskets: PTFE.

d. Handwheel: ASTM A536.

B. Valves 2-1/2-inch (65 mm) to 3-inch (75 mm):

1. Working Pressure: ANSI Class 150.

2. OS&Y, bolted bonnet, solid or flexible wedge disc type.

3. Ends: Flanged ANSI B16.5.

4. Materials:

a. Body, Bonnet, Gland Flange and Disc: ASTM A351 CF8M.

b. Stem and Disc Nut: ASTM A276 Type 316 stainless steel.

c. Gland: ASTM A276 Type 304 stainless steel.

d. Packing and Gaskets: PTFE.

e. Handwheel: ASTM A536

2.41 GLOBE VALVES – NON METALLIC:

A. Manufacturers:

1. Spears.

2. Hayward Industrial products.

B. Type: Angle pattern.

C. Size: 1/4-inch (3 mm) through 2-inch (50 mm).

1. Pressure Rating: 150 psi at 70 degrees F (1050 kPa at 21 degrees C).
2. Fine pitched stem threads.
3. Ends: Threaded NPT.

D. Materials:

1. Body, Bonnet, Piston and Stem: PVC.
2. Seats and Seals: Viton.

2.42 NEEDLE VALVES:

A. Valves 1/2 inch (13 mm).

B. Materials:

1. Body: Type 303 stainless steel.
2. Needle: Type 316 stainless steel.
3. Seals: EPDM.

C. Pressure Rating: 150 psi (1050 kPa).

D. Ends: Threaded.

2.43 NEEDLE VALVES – NON METALLIC:

A. Manufacturers:

1. Spears.
2. Hayward Industrial products.

B. Size: 1/4-inch (6 mm) through 1/2-inch (13 mm):

1. Pressure Rating: 150 psi at 70 degrees F (1050 kPa at 21 degrees C).
2. Fine pitched stem threads.
3. Ends: Threaded NPT.

C. Materials:

1. Body, Bonnet and Stem: PVC.
2. Seats: PTFE End Connectors: CPVC.
3. O-rings: Viton.

2.44 SOLENOID VALVES:

A. Manufacturers:

1. JD Gould.

2. ASCO.

3. Bürkert.

B. Type:

1. Size: 1/8-inch (3 mm) to 2-inch (50 mm).

2. Globe type.

3. 2-way, internal piston pilot operated.

4. Energize to open.

5. Operating Pressure Differential: 150 psi (1050 kPa).

C. Materials:

1. Body: Type 316 stainless steel.

2. Seat Discs: PTFE.

3. Piston Assembly: Type 316 stainless steel.

4. Pilot Assembly: Type 316 stainless steel jacket welded on steel core.

D. Coil: Class F.

E. Electrical: 120 Volt, 1 phase, 60 Hertz.

F. Ends: Threaded.

G. Enclosure: NEMA 4X for locations in non-classified areas and NEMA 7 for use in classified areas.

2.45 WATER PRESSURE REGULATORS:

A. Provide water pressure regulators as specified and indicated.

1. Provide sizes and flow rates as specified and indicated.

B. Provide self contained units operated by internal spring loaded diaphragms or pistons.

1. Provide regulators of spring-opposed bronze piston type where not available in diaphragm configuration.

C. Materials:

1. Body and spring chambers: Type 316 stainless steel.

2. Steel body seat: Type 316 Stainless.

3. Seat disk: Buna-N.

4. Diaphragms: Buna-N reinforced.

D. Provide regulators constructed such that all repairs may be performed with valve in-line.

E. Provide regulators with top adjusting screw to set downstream pressure.

F. Provide regulators sized for required flows with inlet pressure and outlet pressure as indicated. Pressure variation at outlet of greater than 15 psig (105 kPa) at maximum required flows is not acceptable.

2.46 AIR RELEASE VALVES – CLEAN WATER SERVICE:

A. Manufacturers:

1. Val-Matic.

2. Crispin.

3. DeZurik-APCO

4. ARI.

B. Valves: Provide air release valves of the automatic float operated type designed to release accumulated air from a piping system while the system is in operation and under pressure.

C. Provide valves manufactured and tested in accordance with AWWA C512.

D. Provide valves used in potable water service certified to ANSI/NSF 61 Drinking Water System Components - Health Effects.

E. Valve manufacturer must have a quality management system that is certified to ISO 9001:2000 by an accredited, certifying body.

F. Provide valves with the cover bolted to the valve body and sealed with a flat gasket.

G. Provide replaceable resilient seats.

H. Provide drop tight shut off to the full valve pressure rating.

I. Provide floats guaranteed against failure including pressure surges.

J. Mechanical linkage to provide sufficient mechanical advantage so that the valve will open under full operating pressure.

1. Simple lever designs: Provide valves consisting of a single pivot arm and a resilient orifice button.

2. Compound lever designs: Provide valves consisting of two levers and an adjustable threaded resilient orifice button.

K. Provide valve body with threaded NPT inlets and outlets.

1. Inlet Connection: Provide hexagonal for a wrench connection.

2. Working Pressure: As per Valve Schedule.

3. Provide valves with two (2) additional NPT connections with ball valves as specified herein, one connection with a plug and one with a hose coupling for the gauges, testing, and draining.

4. Provide a vacuum check on the outlet to prevent air from re-entering the system during negative pressure conditions.

L. Provide valves with an inflow preventer to prevent the introduction of contaminated water through the air valve outlet.

1. Provide the inflow preventer to allow the admittance and exhausting of air while preventing contaminated water from entering during normal operating conditions.

a. Provide the inflow preventer flow tested by an independent testing lab approved by the American Society of Sanitary Engineers.

M. Materials:

1. Valve Body, Cover and Baffle:

a. ASTM A126 Class B cast iron for working pressures up to 300 psig (2100 kPa).

b. ASTM A536 Grade 65-45-12 Cast Ductile Iron. For working pressures 300 psig (2100 kPa) and greater.

c. ASTM A216 Grade WCB cast steel.

d. ASTM A351 Grade CF8M stainless steel.

e. ASTM B584 Alloy C83600 cast bronze.

2. Floats, Orifice and linkage: Type 316 stainless steel, non-metallic components are not acceptable.

3. Orifice Button: Viton for simple lever valves and Buna-N for compound lever designs.

4. Hardware: Type 316 stainless steel.

5. Screened Hood: Type 316 stainless steel.

N. Testing:

1. Test valves at 1.5 times the rated working pressure.

2.47 AIR RELEASE VALVES – WASTEWATER SERVICE:

A. Manufacturers:

1. Vent-o-mat (anti-shock).
2. Val-Matic.
3. Crispin.
4. DeZurik-APCO.
5. ARI

B. For wastewater services provide valves with the following:

1. Fully automatic float operated valves designed to release air from the piping system while the system is in operation and under pressure.
2. Extended valve body.
3. 2-inch (50 mm) cleanout.
4. Minimum 2-inch (50 mm) inlet.
5. 1/2-inch (13 mm) outlet with stainless steel ball valve with hose connection.
6. 1-inch (25 mm) drain with stainless steel ball valve.
7. Provide ball valve as specified herein.

C. Valves 3-inch (75 mm) and Smaller: NPT inlet and outlet connections equivalent to the valve size.

1. Provide stainless steel ball valve for isolation as specified herein.

D. Valves 4-inch (100 mm) and Larger: Flanged inlet and outlet connections equivalent to the valve size.

1. Provide plug valve for isolation as specified herein.
2. Flanges: ANSI B16.1 Class 125.
3. Flanges: ANSI B16.42 Class 300.

E. Provide valves with two (2) additional NPT connections for the addition of gauges and for testing, and draining.

F. Provide valve body with a through flow area equal to the nominal valve size.

G. Provide valves with a bolted cover and flat gasket.

1. Valves 4-inch (100 mm) and Larger: Provide cover fitted to the valve body with a machined registered fit.

H. Provide guide shafts supported by bushings.

1. Valves 4-inch (100 mm) and Larger: Provide float double guided and a resilient bumper.

I. Floats: Provide floats with bottom shaped for accelerated closure.

J. Seats to provide drop tight shut off at full valve pressure rating.

K. Provide vacuum check on valve outlet to prevent air from re-entering the system during negative pressure conditions.

L. Materials:

1. Valve Body, Cover and Baffle:

a. ASTM A126 Class B Cast Iron for Class 125 valves.

b. ASTM A536 Grade 65-45-12 Cast Ductile Iron, ANSI Class 300.

c. ASTM A216 Grade WCB cast steel, ANSI Class 300.

d. ASTM A351 Grade CF8M stainless steel.

2. Floats, Guide Shafts and Bushings: Type 316 stainless steel.

3. Seats: Buna-N.

4. Hardware: Type 316 stainless steel.

5. Interior Valve Coating: Fusion bonded epoxy.

2.48 AIR/VACUUM VALVES – VERTICAL WET PIT PUMPS:

A. Manufacturers:

1. Val-Matic

2. Crispin.

3. DeZurik-APCO.

4. Vent-O-Mat.

B. Valves: Fully automatic float operated valves designed to vent air within the pump discharge column on pump start-up and allow air to re-enter the column on pump shutdown or if a negative pressure occurs.

C. Provide with flanged inlet connections equivalent to the valve size. Provide Valves 6-inch (150 mm) and smaller with NPT outlet connections and valves larger than 6-inch (150 mm) with flanged outlet connections.

1. Flanges: ANSI Class 150

D. Provide valves with two (2) additional NPT connections for the addition of Air Release Valve, gauges, testing, and draining.

E. Provide valve body with a through flow area equal to the nominal valve size.

F. Provide valves with a bolted cover and flat gasket. Provide cover fitted to the valve body with a machined registered fit.

G. Provide guide shafts supported by bushings.

1. Provide float double guided and a resilient bumper.

H. Seats to provide drop tight shut off at full valve pressure rating.

1. Provide an anti slam device.

I. Anti Slam Device:

1. Provide for valves 6-inch (150 mm) and larger.

2. Flanged globe pattern spring operated device with a center guided disc and seat assembly.

3. Provide the disc with threaded ports to provide adjustment of flow rate.

4. Provide the device mounted on the valve inlet.

5. Seat and Disc: ASTM A351 Grade CF8M Stainless Steel.

J. Materials:

1. Valve Body, Cover and Baffle:

a. ASTM A126 Class B Cast Iron for Class 125 valves.

b. ASTM A536 Grade 65-45-12 Cast Ductile Iron for Class 300 valves.

2. Floats, Guide Shafts and Bushings: Type 316 stainless steel.

3. Seats: Buna-N.

4. Hardware: Type 316 stainless steel.

5. Springs: ASTM A313 Type 302 stainless steel.

2.49 VACUUM RELIEF VALVES:

A. Manufacturers:

1. Val-Matic

2. Crispin.

3. DeZurik-APCO.

B. Vacuum Valve: Provide fully automatic, center guided, spring loaded disc designed to admit large quantities of air during the draining of the pipe or if a negative pressure occurs.

C. Spring: Designed for a minimum of 100,000 cycles without failure and provide a seat cracking pressure of 0.25 psi (1.25 kPa) and to fully open the valve at a pressure differential of 2 psi (14 kPa). Spring Material: Type 302 stainless steel.

D. Provide valve with a bolted cover and bottom inlet.

E. Provide a through flow area equal to the nominal size of the valve.

F. Provide seat with machine registered fits to the body to insure proper alignment of the guide shaft and operation of the seat.

G. Provide Type 316 stainless steel bird screen on the inlet.

H. Floats: Type 316 stainless steel with Type 316 stainless steel guide shaft, bushing and fasteners. Float shall be center guided. A resilient bumper shall be provided to cushion the float during sudden opening.

I. Valve Seats: ASTM A351 Grade CF8M stainless steel.

J. Seals: Type 316 stainless steel and Buna-N.

K. Valves shall be rated for ANSI Class 150 constructed of ASTM A536 Grade 65-45-12 ductile iron.

L. Provide ANSI Class 150 flanged bottom connection.

1. Provide size as indicated.

2.50 CORPORATION STOPS:

A. Materials:

1. Body, packing nut and solution tube adaptor: Brass.

2. Chain: Type 316 stainless steel.

B. Provide ground key type with inlet thread of steep taper type.

C. Provide outlet connections to suit type of pipe or tubing connected.

1. Nozzle material: 1/2-inch (13 mm) Schedule 80 CPVC.

2.51 CHAINWHEEL OPERATORS – STAINLESS STEEL (DUCTILE IRON):

A. Provide chainwheels with chain and chain guides. For all valves with handwheels or gear operators higher than 6.5 feet (2 metres) above operating floor level.

B. Provide chain that reaches to within 3 feet (1 metre) of the operating floor level.

C. For valves with gear operator mount with chainwheel in the vertical position.

D. Provide secondary safety restraint system.

E. Manufacturer:

1. Trumbull.

F. Materials:

1. Chainwheels: Pocket type wheel, Type 316 stainless steel.

2. Chain: Type 316 stainless steel straight link machine chain.

3. Hardware and Attachments: Type 316 stainless steel.

4. Safety Restraint Cables and Hardware: Type 316 stainless steel.

G. Materials:

1. Chainwheels: Sprocket type wheel, ductile iron.

2. Chain: Galvanized steel connecting link chain.

3. Hardware and Attachments: Galvanized steel.

4. Safety Restraint Cables and Hardware: Type 316 stainless steel.

2.52 SHEAR GATES:

A. Full opening, circular port, iron body bronze mounted design.

B. Ends: Flanged, standard frame, hub end, spigot end as indicated.

C. The body (frame), gate and wedges: cast iron conforming to ASTM A126 Class B.

D. Provide valves with two (2) wedges bolted to the body so they can easily be removed and replaced due to wear.

E. Provide the gate to pivot on a solid bronze hinge pin.

F. Provide the bronze gate (seat) ring rolled into a dovetailed groove under pressure to make one inseparable unit.

1. Bronze gate ring: Machined to a smooth finish.

2. Body seat ring: Bronze, threaded and screwed into place and the face machined to a smooth finish.

G. Provide an adjustable stop on wedge to prevent jamming gate to seat.

H. Provide lifting handles of sufficient length to operate as indicated.

2.53 FLOORSTANDS-NRS INDICATING TYPE:

A. Type: Non-Rising Stem (NRS), Indicating.

B. Materials:

1. Pedestal: Cast Type 316 stainless steel with a vertical indicating slot.

2. Indicator: Bronze. Provide indicator that travels on a threaded stem to indicate the position of the valve.

3. Handwheel: Type 316 stainless steel, 12-inch (300 mm) diameter.

4. Couplings: Type 316 stainless steel.

C. Provide the word “OPEN” cast in the pedestal at the top of the indicating slot and provide a “CLOSED” tag mounted to the pedestal, to indicate the closed position of the valve.

D. Floorstands fabricated by welding flanges to pipe are not acceptable.

2.54 EXTENSION STEMS:

A. Provide where indicated and required for operation of all valves

B. Material:

1. Stems: Type 316L solid stainless steel bar or Schedule 40 Type 316L pipe

a. Minimum Size: 1.25 inch (32 mm) diameter, Slenderness ration <200

2. Connectors, thrust relief assemblies, torque tube assemblies, universal joints and operating nuts: Type 316 or Type 316L stainless steel

3. Miter gears: Cast iron with 2 part epoxy coating

2.55 FLOOR BOXES-CAST IRON

A. Manufacturer:

1. Trumbull Industries.

B. Provide floor boxes where indicated to provide support for extension stems for non-rising stem valves and a cover for the operating nut.

C. Floor Box Depth: 6 inches (150 mm) and capable of use in thicker floors with a 2-1/2 inch (65 mm) or 3 inch (75 mm) schedule 40 steel pipe nipple

D. Materials:

1. Body and Cover: Cast Iron ASTM A126

2. Bushing: Bronze, NSF 61

3. Hardware: Type 316 stainless steel

2.56 FLOOR BOXES-STAINLESS STEEL WITH PACKING

A. Manufacturer:

1. Trumbull Industries.

B. Provide floor boxes where indicated to provide support for extension stems for non-rising stem valves and a cover for the operating nut.

C. Floor Box Depth: 6 inches (150 mm) and capable of use in thicker floors with a 4 inch (100 mm) schedule 80 Type 316L stainless steel pipe nipple.

D. Provide system capable of a maximum 2 inch (50 mm) shaft extension.

E. Provide a water stop welded to the body

F. Provide cover with O-ring seal and six (6) stainless steel socket screws

G. Materials:

1. Body: 6 inch (150 mm) schedule 40 Type 316L stainless steel

2. Cover: Type 316L stainless steel

3. Packing Gland: Bronze, NSF 61

4. Packing: Viton A

5. Hardware: Type 316 stainless steel

H. Where indicated provide floor boxes with stuffing box with bronze, NSF61, glands, Type 316 stainless steel hardware and non-asbestos fiber packing

2.57 FLOOR BOXES-CAST IRON:

A. Manufacturer:

1. Trumbull Industries.

B. Provide valve stem guides where indicated and as required by the valves manufacturer.

C. Stem Guide Spacing: 6 to 8 feet (1.8 to 2.5 metres), maximum slenderness ratio of 200.

D. Stem Guides for Stems 2-inch (50 mm) and Smaller:

1. Materials:

a. Stem Guide: Cast Type 316 stainless steel with 2 to 36 inch (50 to 900 mm) adjustment.

b. Bushing: Bronze, NSF 61

c. Hardware: Type 316 stainless steel.

E. Stem Guides for Stems 2-1/8-inch (54 mm) to 4 inch (100 mm):

1. Materials:

a. Stem Guide: Ductile Iron 65-45-12 with 2-3/4 to 17-1/4 inch (70 to 438 mm) adjustment.

b. Bushing: Split type, Bronze, NSF 61

c. Hardware: Type 316 stainless steel.

2.58 FLOOR BOXES-STAINLESS STEEL WITH PACKING:

A. Manufacturer:

1. Trumbull Industries.

B. Provide position indicators installed on all multi-turn valves and quarter turn valves with gear boxes 3 inch (75 mm) and larger.

1. Type: Planetary gear design.

C. Materials:

1. Provide the sun gear, planet gear, ring gears and scale plate constructed of Delrin.

2. Housings of carbon steel or aluminum are not acceptable.

3. Hardware and Fasteners: Type 316 stainless steel.

D. Position Indicator Design Features:

1. Provide the position indication to show the position of the valve, from fully open to fully closed, identified at ground level.

2. Movement of the indicating arrow must be visible through a window covering a minimum of 300 degrees of the circumference of the indicator.

3. Size of the characters and numerals: minimum 3/16 inch (5 mm).

4. Provide the top scale plate with markings representing the number of turns, contain the word “CLOSED”, and a directional arrow.

5. Provide permanently recessed, embossed or engraved markings in the scale plate. The use of adhesive labels is not acceptable.

6. Provide the “OPEN” line marked on a transparent polycarbonate window, field adjusted for the number of turns of each valve size.

7. Provide the position of the adjustable “OPEN” window secured to the top surface of the scale plate by the outside diameter of three Type 316 stainless button head cap screws.

8. Provide all adapters to secure the position indicator, for installation in either a valve box, floor box or wall bracket as indicated and required.

9. Provide the position indicator and adapter with matching flat sides to prevent rotation of the indicator during operation.

E. Exposed and Submerged Valves:

1. Provide a Type 316 stainless steel extension stem connected to a 2 inch (50 mm) square nut on the valve and extend up through the position indicator, terminating in a 2 inch (50 mm) square nut, operable by a standard waterworks tee-handle wrench.

F. Buried Valves:

1. Provide the position indicator installed in a valve box within 6 inches (150 mm) of grade.

G. Valves Installed Inside a Structure:

1. Provide the position indicator installed in a floor box.

2. Where a floor is not directly over the valve and extension stem, support position indicators with a Type 316 stainless steel wall bracket mounted to a side wall.

3. When installed in a floor, provide the adapter with a bronze bushing to support and center the extension stem with the bronze bushing retained in the cast iron floor adapter by two Type 316 stainless steel screws and drilled to an inside diameter 1/16 inch (1.6 mm) larger than the outside diameter of the extension stem.

2.59 STEM GUIDES:

A. Manufacturer:

1. Trumbull Industries.

B. Provide valve stem guides where indicated and as required by the valves manufacturer.

C. Stem Guide Spacing: 6 to 8 feet (1.8 to 2.5 metres), maximum slenderness ratio of 200.

D. Stem Guides for Stems 2-inch (50 mm) and Smaller:

1. Materials:

a. Stem Guide: Cast Type 316 stainless steel with 2 to 36 inch (50 to 900 mm) adjustment.

b. Bushing: Bronze, NSF 61

c. Hardware: Type 316 stainless steel.

E. Stem Guides for Stems 2-1/8-inch (54 mm) to 4 inch (100 mm):

1. Materials:

   a. Stem Guide: Ductile Iron 65-45-12 with 2-3/4 to 17-1/4 inch (70 to 438 mm) adjustment.

   b. Bushing: Split type, Bronze, NSF 61

   c. Hardware: Type 316 stainless steel.

2.60 POSITION INDICATORS:

A. Manufacturer:

   1. Trumbull Industries.

B. Provide position indicators installed on all multi-turn valves and quarter turn valves with gear boxes 3 inch (75 mm) and larger.

   1. Type: Planetary gear design.

C. Materials:

   1. Provide the sun gear, planet gear, ring gears and scale plate constructed of Delrin.

   2. Housings of carbon steel or aluminum are not acceptable.

   3. Hardware and Fasteners: Type 316 stainless steel.

D. Position Indicator Design Features:

   1. Provide the position indication to show the position of the valve, from fully open to fully closed, identified at ground level.

   2. Movement of the indicating arrow must be visible through a window covering a minimum of 300 degrees of the circumference of the indicator.

   3. Size of the characters and numerals: minimum 3/16-inch (5 mm).

   4. Provide the top scale plate with markings representing the number of turns, contain the word “CLOSED”, and a directional arrow.

   5. Provide permanently recessed, embossed or engraved markings in the scale plate. The use of adhesive labels is not acceptable.

   6. Provide the “OPEN” line marked on a transparent polycarbonate window, field adjusted for the number of turns of each valve size.

   7. Provide the position of the adjustable “OPEN” window secured to the top surface of the scale plate by the outside diameter of three Type 316 stainless button head cap screws.

   8. Provide all adapters to secure the position indicator, for installation in either a valve box, floor box or wall bracket as indicated and required.

9. Provide the position indicator and adapter with matching flat sides to prevent rotation of the indicator during operation.

E. Exposed and Submerged Valves:

1. Provide a Type 316 stainless steel extension stem connected to a 2 inch (50 mm) square nut on the valve and extend up through the position indicator, terminating in a 2 inch (50 mm) square nut, operable by a standard waterworks tee-handle wrench.

F. Buried Valves:

1. Provide the position indicator installed in a valve box within 6 inches (150 mm) of grade.

G. Valves Installed Inside a Structure:

1. Provide the position indicator installed in a floor box.

2. Where a floor is not directly over the valve and extension stem, support position indicators with a Type 316 stainless steel wall bracket mounted to a side wall.

3. When installed in a floor, provide the adapter with a bronze bushing to support and center the extension stem with the bronze bushing retained in the cast iron floor adapter by two Type 316 stainless steel screws and drilled to an inside diameter 1/16-inch (1.6 mm) larger than the outside diameter of the extension stem.

2.61 ELECTRIC MOTOR ACTUATORS:

A. Provide in accordance with Section 40 23 13.03.

2.62 SHOP PAINTING:

A. Coat internal and external ferrous surfaces of valve with NSF Certified Epoxy in accordance with ANSI/NSF Std. 61, and in conformance to AWWA D102 Inside System No. 1 for all valves not specified to have a fusion bonded epoxy coating.

B. Process Valve Color: Red.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.

B. Clean all debris, dirt, gravel, etc, from inside of piping before placing valves in place.

C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which do not operate easily or are otherwise defective at no additional cost to the Owner.

D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.

E. Provide bolted split sleeve coupling or flexible type grooved coupling on downstream side of buried valves to assist in valve removal.

F. Where indicated provide Type 316 stainless steel stem extension to operating floor elevation as shown and provide the bevel gear operator with a fabricated steel floorstand and handwheel.

3.02 GATE AND KNIFE GATE VALVES:

A. Install gate valve stem as shown or with stems between vertical and 45 degrees above the horizontal. Valves installed with stems below horizontal are not acceptable.

3.03 CHECK VALVES:

A. Install swing check valves horizontally in pipelines unless otherwise indicated.

3.04 PLUG VALVES:

A. Install valves in horizontal piping with shaft horizontal such that in open position, plug is located in upper part of valve body. Orient valves so that in closed position, flow is against the face of the plug.

3.05 FLOORSTAND OPERATORS AND STEM GUIDES:

A. Set floorstand operators and stem guides so stems run smoothly in true alignment. Anchor guides to walls. Check distances from centerlines of gates to operating level or base of floorstand and adjust if to suit actual conditions of installation.

3.06 VALVE BOXES:

A. Provide valve box for each buried valve and where indicated.

B. Set box so top is flush with finished surface and so box does not bear on valve, or pipe.

3.07 FIELD TESTING:

A. Pressure test valves with pipeline pressure testing.

B. Test functions of each valve.

C. Make all adjustments necessary to place valves in specified working order at time of above tests.

D. Remove all replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.08 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.09 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 40 23 13.01

SECTION 40 23 13.03

ELECTRIC MOTOR ACTUATORS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide electric motor actuators and appurtenances as indicated and in compliance with Contract Documents.

1. Actuators for all valves, gates and equipment to be the product of one manufacturer.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.

2. B179: Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes.

B. FM Global (FM):

1. 3615: Explosionproof Electrical Equipment General Requirements.

C. Institute of Electrical And Electronics Engineers (IEEE):

1. 802.15.4: Standard for Information Technology.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Certified shop and erection drawings.

a. Drawings shall be in conformance with all other requirements as specified in this specification.

2. Data, regarding actuator and motor characteristics and performance.

3. Actuator and Valve set-up for each application: Position or torque seating

4. Shop drawing data for accessory items.

5. Manufacturer’s literature as needed to supplement certified data.

6. Operating and maintenance instructions and parts lists.

7. Listing of reference installations as specified with contact names and telephone numbers.

8. Actuator shop test results.

9. Motor shop test results.

10. Qualifications of field service engineer.

11. Schematic control and power wiring diagrams.

12. Shop and Field inspections reports.

13. Recommended spare parts other than those specified.

14. Recommendations for short and long term storage.

15. Special tools.

16. Shop and field testing procedures and equipment to be used.

17. Torque capability and settings for each actuator.

    a. Provide a listing of operating torque, safety factor applied and actuator torque capability and actuator safety factor as specified for each valve, gate and equipment.

18. Number of service person days provided and per diem field service rate.

19. Manufacturer's product data and specifications for shop painting including statement of compliance for compatibility with field painting.

20. Provide a listing of the materials recommended for each service specified and indicated.

21. ISO 9001 certification.

22. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of three (3) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".

    1. Failure to include all drawings or a statement application to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide for each Actuator:

1. Two fuses of each size

C. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. One set of all special tools

2. Supply each actuator with a start-up kit consisting of installation instructions, electrical wiring diagrams and two sets of cover screws and seals.

1.05 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified herein.

B. Actuators for all valves, gates and equipment to be the product of one manufacturer.

1. Contractor to coordinate with all valve, gate and equipment suppliers.

C. Actuators to be manufacturer's standard cataloged product and modified to provide compliance with the specifications and the service conditions specified and indicated.

D. Shop tests as specified.

E. Provide Services of Manufacturer's Representative as stated in Section 01 61 00 and as specified herein.

F. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect setting, alignment, field erection; coordination of, electrical and miscellaneous utility connections:

a. 1/2 person-day per actuator.

3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.

a. 1/2 person-day per actuator.

4. Field Performance Testing: Field performance test equipment specified.

a. 1/2 person-day per actuator.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classrooms sessions.

a. 2 person-days, 2 trips.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service engineer to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

G. Manufacturer of actuators must have at least five (5) operating installations with actuators of the type and size specified and in the same service as specified operating for not less than five (5) years.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Section 01 61 00 and as specified

PART 2 - PRODUCTS

2.01 ELECTRIC ACTUATORS – 3 PHASE:

A. Each actuator shall include electric motor, reduction gearing, reversing starters, thermal overloads, controls transformer, limit controls, non-intrusive local controls as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.

1. Provide actuators capable of setting of torque, turns, and configuration of indication contacts, through the use of a non-intrusive infra-red setting tool without the necessity to remove any electrical compartment covers. The setting tool must be the means for adjustment. The use of control knobs for programming the actuator is not acceptable.

2. Provide actuators with torque capability 150 percent above the maximum operating torque required by each valve, gate or equipment.

3. Enclosure:

a. Watertight to IP68, classification. Enclosure must be certified NEMA 6 for all units except those in classified areas.

b. Provide explosion proof Class 1, Division 1, Groups C, D, E, F, & G. NEMA 7 FM (Factory Mutual) certified to FM3615 for actuators as indicated and located in classified areas.

4. Provide an internal watertight compartment to protect switches, contacts, motor and internal electronics from ingress of moisture and dust when the external terminal cover is removed.

5. Breathers, drains and or heaters are not permitted, enclosure must be totally sealed.

6. Provide each actuator with a handwheel for manual operation. Provide a hammerblow device which permits motor to come up to speed before picking up load and unseating valve.

B. Motors:

1. Open/Close applications: Motors, Class F with 15 minute duty rating.

2. Modulating applications: motors, Class H with a 30 minute duty rating.

3. Motor: Low inertia, high torque type, specifically designed for use with motor actuators, to prevent over travel.

C. Provide internal clutch that cannot engage handwheel operating mechanism and motor-operating mechanism at the same time. Friction type declutching is not acceptable.

1. Provide handwheel with arrow and the word CLOSE or SHUT cast on handwheel to indicate turning direction to close.

2. Handwheel must not rotate during power operation.

3. Provide handwheel and low gear ratio combined to give maximum rate of movement possible with 80 lb rim pull.

D. Drive Unit:

1. Metal worm wheel and worm shaft type.

2. Provide an oil filled drive housing. Grease lubrication is not acceptable.

3. Worm shaft to operate in ball or roller bearings and be machine cut, ground, and highly polished, hot rolled steel, hardness 50-60 Rockwell Scale C bronze worm wheel with large contact area. Provide mating surfaces of dissimilar metals to prevent galling. Cast metals or gears manufactured from non-metallic materials are not acceptable.

4. Worm and shafts: Heat treated steel and accurately machined. Output or driving shaft to operate in bronze bearing or in ball or roller bearings.

5. Make provisions to take thrust in both directions.

6. Worm and wheel to be oil lubricated at all times.

7. Drive housing: Cast iron or aluminum depending on size of actuator offered, all thrust or torque bearing components shall be ductile iron.

8. Provide drive bushing as part of a detachable thrust base making for easy retrofit.

E. Fully wire electric motor operators at factory and furnish complete with terminal strips for external power and control connections. Wiring: copper with tropical grade PVC cover. Internal wiring to remain in a water tight compartment with external cover removed.

F. Provide manual or automatic control as indicated and specified.

G. Operating Speed:

1. Gates: provide actuators for opening and closing at 12 inches per minute or as indicated on the Slide Gate Schedule.

2. Valves: Provide actuators to open or close the valves under the working pressures indicated in 1 minute.

H. Manual Control: Provide the following Control, Status, Alarm and Diagnostic capabilities locally, at the actuator:

1. Control:

a. Open /Close selector switch

b. Stop pushbutton

c. Local/Remote selector switch

2. Status:

a. Motor Running Open Direction.

b. Motor Running Close Direction.

c. Fully Open.

d. Fully Closed.

3. Alarms:

a. Remote Control Communications Failure.

b. Actuator Alarm.

c. Valve Alarm.

d. Battery Low Alarm.

4. Diagnostics:

a. Provide an integral diagnostic module, which will store and enable download of historical actuator data to permit analysis of changes in actuator, gate or valve performance. Access to data shall be via a non-intrusive an IrDA™ port to an appropriate devise capable of standard IRDA communications i.e. Notebook PC,

Windows CE based "Personal Digital Assistant (PDA)" or an IrDA™ compatible cellular telephone.

b. Provide diagnostic software from actuator manufacturer to allow configuration and diagnostic information to be reviewed, analyzed and reconfigured. Provide diagnostic status screens capable of showing multiple functions simultaneously so troubleshooting can be affected rapidly and efficiently.

I. Automatic Control: Provide REMOTE automatic control specified in Section 40 90 00 and as indicated.

J. Provide each actuator fitted with four (4) hard-wired configurable contacts. Each Contact shall be rated at 5A, 250VAC, 30VDC and able to provide any one of the following:

1. Status:

a. Valve Fully Open.

b. Valve Fully Closed.

c. Valve Opening or Closing.

d. Valve Moving (Continuous or Pulsing).

e. Local Stop Selected.

f. Local Selected.

g. Remote Selected.

h. Open or Close Interlock Active.

i. ESD Active.

2. Alarms:

a. Motor Tripped on Torque in Mid-Travel.

b. Motor Tripped on Torque Going Open.

c. Motor Tripped on Torque Going Closed.

d. Pre-Set Torque Exceeded.

e. Valve Jammed.

f. Actuator Being Operated by Handwheel.

g. Lost Main Power Phase.

h. Customer 24V DC or 120V AC Supply Lost.

i. Battery Low.

j. Internal Failure Detected.

k. Thermostat Tripped.

K. Provide a back-up power source integral to the actuator to ensure that in the event of a main power supply loss or failure that the LCD display indication contacts must remain operational for a minimum of 24 hours and still function on change of status.

L. Provide contacts and operating parts made of non-corrodible metal and suitable for a sea atmosphere and for contact with H_2S.

M. Control

1. Provide non-intrusive selectors on actuator electrical controls cover. One for Local/Stop/Remote selection, pad-lockable in each position and the other for local Open/Close control. Switches penetrating the housing are not acceptable.

N. Starters/transformers: Consists of two relay contactors, 3-pole, mechanically interlocked, reversing with suitable arc suppressors.

1. Electrical Service:

a. 460V, 3-phase, 60 Hertz.

2. Provide inverse time element overload relays.

3. Provide a control transformer capable of generating either 110VAC (220VAC) or 24VDC.

4. Provide electromechanical starter capable of OPEN/CLOSE sixty starts per hour or solid state starter for modulating service capable of 1200 starts per hour.

5. Provide replaceable fuses to protect wiring, fuses must be locally available.

6. Provide automatic phase correction.

O. Limit Controls:

1. Type: Positive in action ensuring tight seating and full openings.

2. Position Setting Range: 2.5 to 100,000 turns, with resolution of 7.5 degrees of one actuator output revolution.

3. Provide mechanism designed to minimize drift or over-travel and to open or close valve, gate or equipment to fixed, predetermined limits of opening and closing travel.

4. Provide controls that disconnect driving mechanism from stem utilizing Hall effect magnetic pulse system or similar technology. Measurement of torque shall be by direct measurement of force at the output of the actuator. Methods of measuring torque derived from the motor such as motor speed, current, flux, are not acceptable. Position and torque sensor shall accurately measure and control the position of the actuator without the use of mechanical gears. Potentiometers for position transmission are not acceptable.

5. Provide torque switches for both directions of travel.

a. Sensing to be independent of voltage fluctuation.

b. Provide torque protection to prevent repeated starting in the same direction.

c. The initial unseating hammer blow shall not cause overtorque.

d. Provide torque switch settings independent of OPEN/CLOSE position switches.

P. Provide output drive coupling to accept rising stem for rising spindle valves and include roller and ball type thrust bearings.

Q. Provide actuator sized to close valve, gate or equipment against differential pressure as specified and indicated. Size actuator motor to seat and unseat valve gate or equipment and ensure torque switch trip at maximum valve torque when supply voltage is 10 percent below normal. Size motor to open or close valve, gate or equipment to satisfy the process dynamics.

R. All fasteners and hardware: Type 316 stainless steel.

S. Secondary Gear Boxes:

1. Provide secondary gearing for multi turn or quarter-turn applications where operating times, thrust or torque considerations require.

a. Secondary Gearing: Bevel or spur, totally enclosed in a cast iron housing, fully sealed and lubricated for the service indicated and specified.

2. Provide gear assemblies that are a manufacturer's standard selection or combination of as detailed in published product literature.

a. Provide each gearbox with a removable output drive coupling sized for the service specified and indicated.

b. Provide quarter-turn gearboxes equipped with adjustable mechanical stops (at 0 and 90 degrees +/- 5 percent) to permit limiting open and closed travel during manual operation.

c. Factory prime and finish paint all gear boxes with 2 part high solids epoxy or as specified herein for the actuator.

T. Actuator Control System:

1. Provide a two wire digital system. The control system shall be a standard product of the actuator manufacturer.

2. Provide the controls system including field units and master stations.

a. Control Systems using PLCs are not acceptable.

b. Control Systems must have a current operating gateway to the DCS system.

3. Provide the Control System with the following features:

a. Hard wired two wire data highway for both OPEN/CLOSE and modulating service.

b. Provide the control system capable of a wireless mesh network utilizing the globally accepted 2.4 GHz frequency range, based on the IEEE 802.15.4 family of PAN standards for future expansion.

c. ROM and battery backed RAM memory.

d. Configured with a PC, hand-held module or master station.

e. Field unit integral to the actuator with parameters stored in EEPROM. The unit shall be powered from the actuator.

f. Provide system so that single shorts, grounds or breaks in the data highway will not affect operation of the loop.

g. Self-diagnostics shall pinpoint any breaks, grounds, shorts, or other faults.

h. Provide the Master Station with color graphical HMI for informational and control access to all loop connected devices.

i. The master station CPU shall incorporate 8080 architecture with 20 bit address bus and 8 bit bi-directional data bus. Isolated I/O and CPU data bus connect to 240 hard wired field units and up to 300 total field units utilizing the wireless network. Read write functions to field I/O 64K I/O addressing. Repeaters are not acceptable within the network wiring.

j. The communication port to the DCS shall comply with the International D type connection standards.

k. Provide the master station with an RJ 45 communication port

l. Provide remote extraction of actuator datalogger and configuration files available via web server capabilities.

m. Provide control platform with the ability to permit e-mail notification of alarm conditions.

2.02 SHOP TESTS:

A. Motor Test:

1. Give each motor a standard commercial test in the shop of the motor manufacturer and submit certified copies of the test results to the Engineer for review prior to installation of the motors.

B. Actuator Testing:

1. Test performance of each actuator. Provide individual test certificates at no additional cost to the Owner simulate a typical valve, gate or equipment load and record the following parameters:

a. Current a maximum torque setting.

b. Torque at maximum torque setting.

c. Test voltage and frequency.

d. Flash test voltage.

e. Actuator output speed or operating time.

2. Test housing oil tightness, 30 psi for 2 minutes.

3. Insulation test on motor and control circuit.

4. In addition, record details of specification on the test certificate, such gear ratios for both manual and automatic drive, closing direction, wiring diagram code number, and when applicable remote transmitter resistance and interposing relay voltage.

C. In event that specified tests indicate that motor or actuator will not meet specifications, Engineer has the right to require complete witnessed tests for all motors and actuators at no additional cost to the Owner.

1. Repeat tests until specified results are obtained.

2. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

2.03 SHOP PAINTING:

A. Paint Finish: Baked on polyester powder coating 70 microns thick and must have passed ASTM B117 35 degrees C Salt Spray Test for 1,000 hours.

1. Provide materials for touch-up of all damaged or abraded surfaces due to installation.

2. Ferrous surfaces obviously not to be painted shall be given a shop applied coat of grease or rust resistant coating.

2.04 DISCONNECT AND LOCAL CONTROL STATION:

A. Enclosure:

1. NEMA 4X (Ingress Protection Rating IP68) Type 316 stainless steel for all non-classified areas.

2. NEMA 7, cast aluminum for all classified areas.

3. Mount on a pedestal, or on adjacent structure.

a. Hardware and Mounting Supports: Type 316 stainless steel.

B. Provide each actuator with a primary voltage rated non-fused disconnect.

C. Provide each actuator mounted in excess of 6.5 feet above the operating level or in a position that cannot be accessed with a single integrated disconnect and local control station. Mount the disconnect and local control station on a wall, column or pedestal 5.0 feet above the operating level.

D. Provide red, green, and yellow indicating lights as on actuator. GREEN light on when valve, gate or equipment is completely closed, RED light on when valve, gate or equipment is completely opened, and YELLOW light when valve, gate or equipment is in mid travel.

E. Control circuits: 24VAC or 120 VAC as required.

F. LOCAL/STOP/REMOTE switch: Padlockable in all positions. With actuator selector set to "Remote" actuator shall be capable of accepting operation input through separate pushbutton station, that pushbutton station has been selected for remote "COMPUTER" control.

G. OPEN/CLOSE switch: With actuator selector set to "Remote", actuator shall be capable of accepting operation input from separate pushbutton station, when pushbutton station has been selected for local "Open/Close" control.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.

3.02 FIELD TESTING:

A. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service engineer, conduct running test for each actuator in presence of Engineer to determine its ability to operate without vibration or jamming and to operate at the speeds specified.

1. During tests, observe and record, motor inputs.

2. Promptly correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results and results acceptable to the Engineer are obtained.

3. Contractor to provide all labor, equipment, and materials necessary for conducting tests.

B. Make all adjustments necessary to place equipment in specified working order at time of above tests.

C. Remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to satisfaction of the Engineer that units will perform the service specified and indicated.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer. Contractor shall apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide submittals in accordance with Section 01 77 00.

END OF SECTION 40 23 13.03

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SECTION 40 23 19.01

PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and in compliance with Contract Documents. The term pipe support includes hangers, guides, restraints, anchors and saddles.

B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.

C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.

D. Pipe support locations and types for piping 1/2-inch and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports 1/2-inch and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.

1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.

E. Design and provide all temporary pipe supports required during installation and testing.

1.02 REFERENCES:

A. The American Society of Mechanical Engineers (AMSE):

1. B31.1: Power Piping.

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

3. A312: Seamless and Welded Austenic Stainless Steel Pipe

4. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.

5. A572: Specification for Steel Plate.

6. E165: Practice for Liquid Penetrant Inspection Method.

7. E709: Practice for Magnetic Particle Examination.

C. American Welding Society (AWS):

1. D1.1: Structural Welding

D. Fluid Sealing Association: Technical Handbook.

E. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design.

2. SP-69: Pipe Hangers and Supports - Selection and Application.

3. SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.

4. SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Pipe support drawings specified herein and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.

a. Detailed drawing of the device with dimensions.

b. A table of applied forces and moments.

c. A complete bill of materials.

d. A unique identification and revision level.

e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified herein.

f. Detailed connections to existing structure.

g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1.

2. Welding Procedure: Submit description required to illustrate each welding procedure to be performed in the specified work.

3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.

4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.

5. Pipe support manufacturers' qualifications as specified herein.

    a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.

    b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.

6. Coordination drawings for pipe supports shall include as a minimum the following information.

    a. Coordination drawings shall include all pipe supports covered by specifications.

    b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.

    c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.

    d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4-inch scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-inches or less in diameter that will be field routed need not be shown on coordination drawings.

    e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.

    f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that

require architectural or structural changes of design shall be submitted to the Owner for resolution.

g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.

h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.

7. Written notification of any deviations from the requirements of this specification.

8. Support documentation and justification as specified.

9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.

10. Manufacturer's product data and specifications for shop painting.

B. Material Certification:

1. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. A copy of the contract mechanical process, and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return

without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.

C. Welder Qualifications:

1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.

D. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

E. Structural Concrete: Conform to the requirements of Section 03 30 00. Concrete strength: 4,000 PSI (28 MPa) unless noted otherwise.

F. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

G. Pipe Support Manufacturer Qualifications:

1. Must possess a written quality assurance program.

2. Have a minimum of 5 years experience in the design and fabrication of pipe supports.

3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.

4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years experience in the design of piping systems and pipe supports.

5. Manufacturers' Standardization Society (MSS) Member.

6. Have a field service technician on staff with at least 5 years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.

H. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all stainless steel piping. Copper plated pipe supports are not acceptable.

B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.

C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.

D. Provide only new material. Previously used and/or scrap material is not acceptable.

E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.

F. Provide sliding Teflon plates. The sliding surfaces shall be a nominal 3/8-inches glass filled Teflon bonded to stainless steel backup plate with a 10 gauge minimum thickness. The bearing pad upper and lower units shall be as follows: Conslide Type CSA elements as manufactured by Con-Serv. Inc., Balco TFE Slide Bearing Plates 10N-cs as manufactured by Balco Inc., or Dynalon Slide Bearings as manufactured by JVI, Inc. or acceptable equivalent product.

1. The blended TFE material used for this bearing shall be composed of virgin (unreprocessed) TFE resin tested per ASTM D1457 and reinforcing agents milled glass fibers. This structural material shall have the following representative mechanical and physical properties:

2. Tensile strength -2,000 psi.

3. Elongation –225 percent

4. Specific Gravity -2.17 to 2.22

5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi.

6. The compressive creep shall be a minimum of 2 percent at 2,000 psi and 70 degrees F.

7. The elements shall be flat, clean and prepared for installation in the structure. Slots and holes shall be fabricated in the bearing manufacturer’s plant.

G. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.

2.02 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS:

A. Design and provide pipe supports for piping 1/2-inch and larger to include the following loads:

1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.

2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.

3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.

4. Wind Loadings: Wind loadings.

B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.

C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.

D. Where possible, provide pipe supports, which are the manufacturers' standard products.

1. Provide pipe supports with individual means of adjustment for alignment.

2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.

3. Hanger rods shall be subjected to tension only.

4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees. Provide base supports designed using pipe slides. The bearing surfaces: 0.06 coefficient of friction or less.

5. Provide concrete inserts capable of supporting the design loads.

6. Metal framing systems will be acceptable to support piping 2 inch and smaller.

7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16 gauge shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 inch in length.

8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.

9. Provide supplementary steel as needed.

10. Do not support pipes from other pipe, conduits or metal stairs.

11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.

12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.

13. All pipe supports located in fluid flow shall be supplied with double nutting.

E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.

F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

G. For piping 2-inch and smaller provide manufacturer's standard supports and standard spacing guidelines

H. Pipe supports connected to structural framing and slabs are subject to the following limitations:

1. Less than 100 lb horizontal load per support.

2. Vertical loads not to exceed an average of 500 psi for slabs, with a maximum vertical load per hanger of 200 lbs.

3. For a maximum of one pipe support per foot of slab width perpendicular to the span.

4. Piping not supported from floors by metal framing must meet the limitations as specified above.

I. All outside above ground supports shall be Type 316L stainless steel as specified herein.

J. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.

K. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.03 FABRICATION:

A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.

B. Providing welding in accordance with Structural Welding Code.

C. Provide dimensional tolerances as specified in MSS-SP-89.

D. Provide threading and tapping in accordance with MSS-SP-89.

2.04 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.

B. Perform welding in accordance with Structural Welding Code:

1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of grove welds for throat opening and for snug positioning for back-up bars.

2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.

3. Magnetic Particle Inspection: Perform in accordance with ASTM E709.

4. Liquid Penetrant Inspection: Perform in accordance with ASTM E165.

5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.

6. Test Locations: As selected by the Owner.

7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.

C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Section 03 30 00.

D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.

F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 inch/100 feet, for each 100 degrees F change in temperature exceed 1/2-inch, provide sliding supports.

I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8-inch thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.

J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.

K. Apply an anti-seize compound to nuts and bolts on all pipe supports.

L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.02 INSTALLATION OF BUILDING ATTACHMENTS:

A. Support piping from structural framing, unless otherwise indicated.

B. Concrete Inserts:

1. Use existing embedded concrete items whenever possible.

2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.03 THRUST ANCHORS AND GUIDES:

A. Thrust Anchors:

1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.

2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.04 PIPE SUPPORTS:

A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.

B. Provide minimum of two pipe supports for each pipe piece.

C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 inch out from face of wall and at least 3 inches below ceiling.

F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.

H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

J. Do not support piping from other piping.

K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

M. All rigid rod hangers shall provide a means of vertical adjustment after erection.

N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.

O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.

P. Hanger spacing shall not exceed the spacing listed below:

1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.

2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.

Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.

R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

S. All threads shall be UNC unless otherwise specified.

T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8-inch fillet weld, 1/2-inch long every 3 inches on center each side of an element shall be used unless otherwise indicated or specified by the manufacturers' written recommendations. Bearing elements with slots or holes shall be stitch welded in place for location. The TFE surfaces of the bearings shall be maintained clean and free from grit, dirt or grease.

3.05 INSULATED PIPING:

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where vapor barriers are indicated on water piping, install coated protective shields.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 40 23 19.01

SECTION 40 23 19.02

STAINLESS STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test stainless steel pipe, fittings and appurtenances as indicated and in compliance with Contract Documents.

B. Pipe and fittings 2-1/2 inch and larger are included in this specification, for pipe and fittings 2 inch and smaller provide in accordance with Section 40 23 19.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (AMSE):

1. B31.1: Power Piping.

B. ASTM International (ASTM):

1. A240: Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

2. A380: Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment and Systems.

3. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.

4. A774: Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

5. A778: Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

C. Fluid Sealing Association: Technical Handbook.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Pipe manufacturer’s technical specification and product data.

2. Certified shop and erection drawings. Contractor shall submit electronic files of the piping layout including the following.

a. Pipe layouts in full detail.

b. Location of hangers and supports.

c. Location and type of anchors.

d. Location of couplings and expansion joints.

e. 1/2-inch = 1 foot-0 inches scale details of all wall penetrations and fabricated fittings or special fittings.

f. Schedules of pipe, fittings, expansion joints and other appurtenances.

3. Certificates: Sworn certificates in duplicate showing compliance with material used and shop tests performed with appropriate standard.

4. Catalog cuts and technical data for expansion joints, couplings, gaskets, pipe supports and other accessories.

5. Submit reports required for welding certifications per ASME B31.1 paragraph 127.6.

6. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.

B. Material Certification:

1. Provide certification from the piping and fittings manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

C. A copy of the contract mechanical process, civil and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return

without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.

C. Welder Qualifications:

1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.

D. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps and equipment to be installed in the piping systems.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. During loading, transportation and unloading, prevent damage to pipes and fittings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation.

PART 2 - PRODUCTS

2.01 STAINLESS STEEL PIPE:

A. Manufacturers:

1. Douglas Brothers

2. Felker

3. J.F. Ahern

4. Dixie Southern

B. Material:

1. Type 316L sheet and plate per ASTM A240.

2. Maximum carbon content of 316L material limited to 0.03 percent.

3. Finish: 2D.

C. Fabrication:

1. Fabricate in accordance with ASTM A778 in NPS sizes shown with dimensional tolerances per ASTM A530.

2. Perform welding by qualified welders conforming to standard procedures. Weld piping with wall thickness up to 11 gauge, 0.125-inch, with the TIG (GTAW) process. Properly bevel heavier walls and use a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process.

3. Add filler wire of ELC grades to all welds to provide a cross section at the weld equal to or greater than the parent metal. Distribute smooth and evenly weld deposit and provide a crown of no more than 1/16-inch on the I.D. and 3/32-inch on the O.D. of the piping.

4. Concavity, undercut, cracks or crevices are not acceptable.

5. Butt Welds: Full penetration to the interior surface, with inert gas shielding provided to the interior and exterior of the joint.

6. Remove excessive weld deposits, slag, spatter, and projections by grinding.

7. Continuously weld angle face rings on both sides to the pipe or fitting.

8. Grind all welds on gasket surfaces smooth.

9. Contour pipe branches, taps and bosses to the radius of the main pipe run and bevel and weld with full penetration. No projections to the inside of the branch or main run are acceptable. Provide a smooth transition from ID of run to ID of branch.

10. Wire-brush inside and outside weld areas with brushes of stainless steel that are specifically designed to be used only on stainless steel.

11. After manufacture, passivate stainless steel pipe, fittings, and appurtenances by immersion in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid. Temperature and detention time to be sufficient for removal of oxidation and ferrous contamination without more than superficial etch of surface. Perform a complete neutralizing operation by immersion in a trisodium phosphate rinse followed by clean water wash. Perform in accordance with ASTM A380.

12. After fabrication, either passivate by immersion (see above paragraph) or scrub interior and exterior of welds with same solution or pickling paste and stainless steel wire brushes to remove weld discoloration and then neutralize and wash clean. Perform in accordance with ASTM A380.

13. Perform all welding in the shop. Field welding is not acceptable.

    a. If field welding is allowed for certain circumstances, the Contractor shall submit the welders qualifications and an acceptable method of cleaning the pipe and fittings for review prior to start of any field welding.

14. Fittings: Butt weld type manufactured in accordance with ASTM A774 of the same raw material and in the same thicknesses as the pipe. Socket weld fittings are not acceptable.

    a. Elbows up to 24-inch diameter: Provide smooth flow-die formed, long radius; with centerline to end of elbow equal to 1.5 times the nominal pipe size.

b. All short radius, special radius, and reducing elbows and long radius elbows greater than 24-inch diameter: Fabricate with pieces in accordance with the following table with dimensions in accordance with AWWA C208:

Bend, degrees	Number of Pieces
0 to 22.5	2
23 to 45	3
46 to 67.5	4
68 to 90	5

15. Fabricate tees and branch connections true and square with wall thickness same as pipe.

16. Reducers evenly tapered with tangent ends for butt weld connection.

    a. Reducers may be straight tapered cone construction.

17. Secure flanges to pipe ends and plug openings prior to shipment.

D. Design:

1. Stainless steel pipe: Nominal pipe size diameter pipe fabricated of stainless steel sheets having the following Schedule, U.S.S. gauges and plate thickness:

Nominal Pipe Size inches	Actual O.D. inches	Schedule/Gauge/Plate	Nominal Wall Thickness inches
2.5	2.875	SCH 5S or 10S	0.083
3	3.500	SCH 5S or 10S	0.083
4	4.500	SCH 5S or 10S	0.083
6	6.625	SCH 5S or 10S	0.109
8	8.625	SCH 5S or 10S	0.109
10	10.750	12 Ga. Sheet	0.109
12	12.750	12 Ga. Sheet	0.109
14	14.000	11 Ga. Sheet	0.125
16	16.000	11 Ga. Sheet	0.125
18	18.000	11 Ga. Sheet	0.125
20	20.000	10 Ga. Sheet	0.140
24	24.000	3/16 inch Plate	0.188
28	28.000	3/16 inch Plate	0.188
30	30.000	3/16 inch Plate	0.188
36	36.000	3/16 inch Plate	0.188
42	42.000	1/4 inch Plate	0.250
48	48.000	1/4 inch Plate	0.250
54	54.000	5/16 inch Plate	0.312
60	60.000	5/16 inch Plate	0.312
66	66.000	1/2 inch Plate	0.500
72	72.000	1/2 inch Plate	0.500
84	84.000	1/2 inch Plate	0.500

2. For buried piping use a minimum SCH 10S or as indicated in the Process Piping Schedule.

3. Joints: Flanged or, bolted split sleeve type couplings as indicated and specified. Split couplings requiring cut or roll grooving of the pipe not allowed unless specifically called for.

4. Flanged Joints: Van Stone back-up flange type, ANSI Class 150 lb. (PN10).

5. Provide stainless steel back-up flanges of the grade of pipe specified with the following thickness. Galvanized steel and ductile iron flanges are not acceptable.

Pipe Size, inches	Flange Thickness, inches
2.5, 3 and 4	0.375
6 and 8	0.500
10 to 18	0.750
20 and 24	0.750
28	0.875
30	0.875
36	1.000
40	1.125
42	1.125
48	1.250
54	1.375
60	1.500
66	1.625
72	1.625

6.

6. Hardware: Type 316 stainless steel.

7. Fabricate flanged joint face rings fabricated of rolled stainless steel angles.

8. Use angle face rings with thickness equal to or greater than the wall of the pipe or fitting to which it is welded. Continuously weld on both sides to the pipe or fitting. Fabricate angle legs so as not to interfere with the flange bolt holes.

9. Isolate stainless steel flanges from all other ferrous metal connections at valves, flanges and equipment with flange insulating kit.

   a. Pipe Flange Insulating Kit:

      (1) Flange gasket: Type E, 1/8-inch thick NEMA Grade G-10 reinforced epoxy retainer with two seals of the following material:

         (a) Potable Water: Teflon or EPDM, NSF61 certified.

         (b) Wastewater and Residuals: Nitrile.

         (c) Aeration Systems: EPDM.

(2) Insulating sleeves: 1/32-inch thick NEMA Grade G-10, full length, one for each flange bolt.

(3) Insulating washers: 1/8-inch thick NEMA Grade G-10, two for each flange bolt.

(4) Mechanical washers: thick Type 316 stainless steel, two for each flange bolt.

(5) Manufacturers:

(a) Trojan Insulating Gasket Advance Products and Systems.

(b) Or equal.

2.02 BOLTED SPLIT SLEEVE TYPE COUPLINGS:

A. Provide stainless steel couplings in accordance with Section 40 23 19.04.

2.03 EXPANSION JOINTS:

A. Provide in accordance with Section 40 23 19.04.

2.04 PIPE SUPPORTS:

A. Provide in accordance with Section 40 23 19.01.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Ensure pipelines parallel to building walls wherever possible. Install piping to accurate lines and grades. Where temporary supports are used, ensure rigidity to prevent shifting or distortion of pipe. Provide for expansion where necessary.

B. Pitch piping toward low points. Provide for draining low points.

C. Before assembly, remove dirt and chips from inside pipe and fittings.

D. Make flanged joints with bolts; bolt studs with nut on each end; or studs with nuts where one flange is tapped.

1. Except as otherwise specified, provide number and size of bolts conforming to same ANSI standards.

2. Provide Type 316 stainless steel hardware.

3. Provide ring gaskets of materials designed for the service specified and indicated, 1/16-inch thick gaskets.

4. Make up flanged joints tight with care being taken to prevent undue strain upon valves or other pieces of equipment.

5. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.

6. Provide insulating kits as specified herein.

3.02 FIELD TESTING:

A. Clean of dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

B. Pressure and Leakage Tests:

1. Conduct combined pressure and leakage test in pipelines.

2. Furnish and install temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.

3. Test when desired and comply with Engineer's orders and specifications.

4. Fill section of pipe with water and expel air.

5. Pressure and leakage test consists of first raising water pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.

6. No visible leakage in joints.

7. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section failed to pass test.

8. If section fails pressure and leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, at no additional expense and without time extension. Conduct additional tests and repairs until section passes test.

9. Immediately upon completion of testing, drain and dry piping to remove all traces of water and condensation.

10. Modifications to test procedure only if permitted by Engineer.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 40 23 19.02

SECTION 40 23 19.03

STEEL PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test steel pipe 10-inch in diameter and larger, fittings and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

3. A307: Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile.

4. A325: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi minimum Tensile Strength.

B. American National Standards Institute (ANSI) Standards:

1. B31.1: Power Piping.

C. American Society of Mechanical Engineers (ASME):

1. B1.1: Unified Screw Threads.

2. B18.2.2: Square and Hex Nuts.

3. Boiler and Pressure Vessel Code Section IX.

D. American Water Works Association (AWWA):

1. C200: Standard for Steel Water Pipe, 6 Inches and Larger.

2. C205: Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-in. and Larger - Shop Applied.

3. C206: Standard for Field Welding of Steel Water Pipe.

4. C207: Standard for Steel Pipe Flanges for Waterworks Service, sizes 4 in. through 144 in.

5. C208: Standard for Dimensions for Steel Water Pipe Fittings.

6. C209: Standard for Cold Applied Tape Coatings for Special Sections, Connections and Fittings for Steel Water Pipelines.

7. C210: Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

8. C213: Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

9. C214: Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines.

10. C222: Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings

11. C602: Standard for Cement-Mortar Lining of Water Pipelines - 4-in. and Larger - In Place.

12. C604: Installation of Buried Steel Water Pipe – 4 inches (100 mm) and Larger

E. Expansion Joint Manufacturers Association: Standards.

F. Fluid Sealing Association - Technical Handbook.

G. Structural Steel Painting Council (SSPC):

1. SSPC-SP10.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the piping layout including the following.

a. Pipe layouts in full detail.

b. Location of hangers and supports.

c. Location and type of anchors.

d. Location of couplings and expansion joints.

e. 1/2 inch = 1 foot-0 inches (1 mm = 25 mm) scale details of all wall penetrations and fabricated fittings or special fittings.

f. Schedules of pipe, fittings, expansion joints and other appurtenances.

g. Electronic files shall conform to the following minimum requirements:

(1) Electronic Files: AutoCAD latest version, drawn to scale.

(2) Submit electronic files as part of the Shop Drawing submittal.

(3) Submit electronic files on CD or DVD.

(4) Drawings shall be in conformance with all other requirements as specified in this specification.

2. Sworn certificates in duplicate of shop tests showing compliance with appropriate standard.

3. Reports of ASME Section IX welding certifications.

4. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.

5. Brochures and technical data on coatings and linings and proposed method for application and repair.

6. Provide record drawings.

7. Provide tag names and numbers for all sections of piping and fittings.

B. Material Certification:

1. Provide certification from the piping and fittings manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

C. A copy of the contract mechanical process, civil and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return

without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Welder Qualifications:

1. Qualify and certify welding procedures, welders, and operators in accordance with ASME Section IX, for shop welding and AWS D1.1 for project site welding of piping work.

2. Qualification for welders: Welding shall be performed by welders holding current certification for the welding procedures in use.

3. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds for defects exceeding tolerances allowed by code under which the weld was made. Repair all defects exceeding tolerance.

B. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, and other equipment to be installed in piping system.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Section 01 66 10.

B. During loading, transportation and unloading, prevent damage to pipes and coatings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to protect pipe, lining, and coating.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Northwest Pipe

B. Ameron

C. Hanson

D. American Spiral Weld

E. Mid America

2.02 MATERIALS:

A. Steel pipe 10-inch to 24-inch: ASTM A53 Type E or S, Grade B, Black.

Nominal Pipe Size, inches	Minimum Wall Thickness, inches

10	0.250 (SCH 20)
12	0.250 (SCH 20)
14	0.250 (SCH 10)
16	0.250 (SCH 10)
18	0.250 (SCH 10)
24	0.250 (SCH 10)

B.

B. Steel Pipe 30-inch diameter and larger: AWWA C200.

Nominal Pipe Size, in	Minimum Wall Thickness, in Interior Piping	Minimum Wall Thickness, in Buried Piping
28	0.250	0.134
30	0.250	0.134
32	0.250	0.156
36	0.250	0.156
40	0.250	0.181
42	0.250	0.181
48	0.250	0.206
54	0.312	0.231
60	0.312	0.256
66	0.375	0.282
72	0.375	0.308
84	0.500	0.358
90	0.500	0.383
96	0.500	0.408
102	0.500	0.433
108	0.500	0.458
114	0.500	0.483
120	0.500	0.508

C.

C. Interior piping wall thickness: Increase wall thickness to limit combined stress (circumferential longitudinal and localized) to 75% of the minimum yield of the steel used.

2.03 PIPE:

A. Fabricate to sizes, dimensions, and shapes indicated.

B. Sizes, Pipe, Fittings and Specials:

1. 12 inch and smaller: Nominal.

2. 14 inch thru 24 inch: Actual outside diameter.

3. 30 inch and larger: Nominal size to be I.D. after lining.

C. Seams:

1. Except for seamless mill type pipe, provide piping fabricated from steel plates rolled into cylinders or sections thereof with longitudinal seams or spiral seams butt welded.

2. Do not use more than two longitudinal seams in piping 72 inch and smaller in size.

3. Butt weld girth seams at least 6 feet apart, except in specials and fittings.

2.04 FITTINGS:

A. Fabricate in accordance with AWWA C208.

B. Provide elbows with the following radius:

1. Interior and Exposed Piping: 1.50 times the nominal diameter

2. Buried Piping: 2.50 times nominal diameter, unless otherwise indicated or specified.

3. Provide elbows in accordance with the following:

Fitting Bend Angle, degrees	Number of Pieces
0 to 22.50	2
23 to 45	3
46 to 67.50	4
68 to 90	5

C. Provide reinforced tees, laterals, and outlets in accordance with ASME Pressure Vessel Code, Section VIII, Paragraph UG-37 or AWWA M-11, Chapter 13.

D. Provide reducing sections with same shell thicknesses required for larger ends.

E. Special Sections:

1. Provide fittings and special sections with ends as indicated and fabricated to shapes, sizes, and dimensions indicated.

F. Small Branch Connections:

1. Provide branch connections 2-1/2 inch and smaller fabricated with welding fittings with threaded outlets.

2. Provide branch connections 3 inch through 12 inch fabricated with pipe nipples or with welding fittings.

3. Provide pipe nipples and welding fittings welded to pipe shell and reinforced to meet working and test pressure requirements.

4. Provide pipe nipples of black steel pipe in accordance with ASTM A53 Type E or S Grade B, minimum thicknesses as listed in the above table.

5. Provide threaded and welded outlets as indicated.

6. Provide small branch connections located so as not to interfere with joints, supports, or other details.

G. Provide fittings shop fabricated from previously hydrostatically tested straight pipe with magnetic particle non-destructive testing of all welds that were not previously tested in the straight pipe.

2.05 FIELD JOINTS:

A. Type as indicated:

1. Location and type of joint may be modified to provide for lining, coating and flexibility in field assembly as accepted by the Engineer.

B. Provide pipe end preparation and tolerances in accordance with AWWA C200.

2.06 FLANGES:

A. Provide in accordance with AWWA C207 depending on pressures.

B. Provide flanged end pipe fitted with slip-on flanges. Provide longitudinal or spiral welds ground flush to accommodate type of flanges provided.

1. Provide bolts and bolt-studs in accordance with AWWA C207 with hexagonal or square heads, coarse thread fit, threaded full length with ends chamfered or rounded.

2. Project bolt ends 1/4-inch beyond surface of nuts.

3. Provide hexagonal nuts with dimensions in accordance with ANSI B18.2.2 and coarse threads in accordance with ASME B1.1.

C. Provide face and finish flanges per AWWA C207.

D. Provide flanges attached normal to axis of pipe for alignment.

E. Provide flanges tested, after welding to pipe, for true plane and reface, to bring them within specified tolerances.

F. Blind Flanges: Conforming in diameter, drilling, and thickness to flanges to which they mate and reinforced to produce a watertight joint under test pressures indicated in the Process Pipe Schedule.

G. Gaskets:

1. Provide gaskets per AWWA C207 made from 1/8-inch thick compressed non-asbestos material.

2. Materials:

a. Water, Wastewater and Sludge Services: Buna N, Neoprene

b. UV Systems: Viton

2.07 WELDED JOINTS:

A. Welds:

1. Sound and free from embedded scale or slag, with tensile strength of weld not less than that of thinner of connected sections. Welds to be watertight.

B. Field welding of lined pipe is not acceptable unless otherwise indicated.

C. Field welds of interior piping: Butt welds.

1. Outside back-up bar may be used.

D. Field welds of buried piping: Bell and spigot lap welds with single weld inside or outside.

E. Provide field welds, in accordance with AWWA C206.

2.08 BOLTED SPLIT SLEEVE COUPLINGS:

A. Joints for lined piping:

1. Provide bolted split sleeve couplings only, welding is not permitted with epoxy lined piping.

B. Provide in accordance with Section 40 23 19.04.

2.09 SLEEVE TYPE COUPLINGS:

A. Joints for lined piping:

1. Provide sleeve couplings only, welding is not permitted with epoxy lined pipe.

B. Manufacturers:

1. Dresser Style 38.

2. Baker.

3. Viking Johnson.

C. Provide plain end type ends to be joined by mechanical couplings in accordance with AWWA C200.

1. Outside diameter and out-of-round tolerances to be within limits specified by coupling manufacturer.

2. Provide lugs in accordance with ASTM A36 or acceptable equivalent product.

3. Provide hardened steel washers in accordance with ASTM A325.

4. Nuts and bolts:

a. Provide bolts and bolt-studs in accordance with ASTM A307 and ASME B1.1 with hexagonal or square heads, coarse thread fit, threaded full length with ends chamfered or rounded.

b. Project bolt ends 1/4-inch beyond surface of nuts.

c. Provide hexagonal nuts with dimensions in accordance with ANSI B18.2.2 and coarse threads in accordance with ASME B1.1.

D. Provide middle ring of each mechanical coupling with a thickness at least equal to that specified for size of pipe on which coupling is to be used and not less than 10 inch long for pipe 30 inch and larger and not less than 7 inch long for pipe under 30 inch in diameter.

1. Omit pipe stop from inner surface of middle rings of couplings to permit removal of valves, flow meters, and other installed equipment.

2. Provide pipe stops in other couplings.

E. Provide cleaning and shop priming with manufacturer's standard rust inhibitive primer.

F. Where noted or indicated, provide mechanically coupled steel pipe joints anchored to steel pipe with harness bolts. Weld harness lugs to steel pipe prior to application of lining.

1. Joint harness bolts: Provide harness lugs placed and provide harness bolts of length such that coupling can be slipped at least in one direction to clear joint. Provide harnesses designed per AWWA M11 to withstand test pressure indicated in Process Pipe Schedule.

2.10 FLANGED COUPLING ADAPTERS:

A. Manufacturers:

1. Dresser "Style 128."

2. Baker.

3. Viking Johnson.ROMAC.

B. Provide restrained flanged coupling adapters.

C. Provide tie rods of sufficient number and strength to restrain coupling at test pressure as indicated in Process Pipe Schedule.

2.11 LINING AND COATING:

A. Lining:

1. Provide lining to the interior of steel pipe, fittings, sleeve couplings and manholes.

2. Provide type of lining as indicated in the Process Pipe Schedule.

B. Polyurethane Lining:

1. Provide lining in accordance with AWWA C222.

2. For buried piping provide 20 mils interior and 25 mils exterior

3. For exposed piping provide 20 mils interior and painting as specified for the exterior

4. Applied per manufacturer's written instruction.

C. Epoxy Lining:

1. Epoxy-phenolic lining shop applied over grit blast cleaned surface, near white per SSPC-SP10.

2. Minimum of two coats providing a total dry film thickness of at least 12 mils of liquid epoxy in accordance with AWWA C210, Tnemec FC22 or fusion bonded epoxy in accordance with AWWA C213.

3. Applied per manufacturer's written instruction.

D. Cement Lining:

1. Provide in-place lining in accordance with AWWA C602 or factory lined in accordance with AWWA C205 as indicated in the Process Pipe Schedule.

2. If piping is factory lined, provide field line welded joints or O-ring field joints in accordance with Section 7 of AWWA C205.

E. Coating:

1. Where sleeve couplings are used, provide coating to pipe ends and exterior surface for a distance of 9 inch with same material as specified for lining.

2. Exposed exterior surfaces of pipe within the building: Commercial blast (SSPC-SP6) and paint with one shop coat of universal primer compatible with field painting Section 09 91 13.

3. Exterior of buried pipe: Coat and wrap with prefabricated multilayer cold-applied polyethylene tape coating in accordance with AWWA C214 Standard.

a. The total nominal thickness of coating: 80 mils consisting of: Primer, 20 mil inner wrap for corrosion protection and two 30 mil outer wraps for mechanical protections.

b. Coat and wrap fittings and field joints with prefabricated multilayer cold-applied polyethylene tape coating in accordance with AWWA C209 Standard. The total thickness of coating shall be 70 mils consisting of: Primer and 2 wraps of 35 mil tape.

(1) Alternate field joint coating: Heat-Shrink sleeves per AWWA C216. Interior welding of joints with Heat-Shrink sleeves can begin once 3 feet of backfill is placed on the pipe.

2.12 SHOP PAINTING:

A. Provide in accordance with Section 09 91 13.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE:

A. Install pipelines per AWWA C604 and parallel to building walls wherever possible. Install piping to lines and grades indicated and support. Where temporary supports are used, provide temporary supports as specified in Section 40 23 19.01 to prevent shifting or distortion of pipe. Provide for expansion.

B. Slope piping toward low points and provide for draining at low points.

C. Before assembly, remove debris from inside pipes and fittings.

D. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth burrs. Make up flanged joints tight, and prevent strain upon valves or other pieces of equipment.

1. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch (13 mm) excess thread protruding from the nut.

E. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system as indicated, and at changes in direction or other places to prevent joints from pulling apart under pressures indicated in the Process Pipe Schedule.

F. Examine pieces for damage. Do not install pieces that are damaged according to Engineer. If any damaged piece should be discovered after having been installed, remove and replace with a sound piece at no additional cost to the Authority.

G. Handle pipe with equipment such as nylon slings and padded skids, designed to prevent damage to the coating. Repair abrasions and injuries to the coating prior to the application of insulation or prior to the application of final field coating.

3.02 INSTALLATION OF LINING AND COATING:

A. After installation of pipe, fittings, and specials, clean, prime, line, and coat as specified for pipe adjacent to weld unlined or uncoated ends adjacent to field welded joints, including weld proper. Repair any damage to lining in accordance with lining manufacturers written recommendations.

B. Preparation of surfaces to be lined and coated after installation of pipe for shop application of coal tar epoxy, except remove foreign matter, including all damaged lining or coating materials, by scraping, chipping, or brushing, and surfaces cleaned to bright metal free of all rust, slag, and scale by means of wire brushing or sand blasting.

C. Use open ends or access manholes for entry for application of interior linings to unlined ends.

D. Pour holes are not allowed.

E. After installation of pipe, fittings, and specials, shop coat on exterior shall be touched up followed by a field coat prior to encasing in concrete.

3.03 INSTALLATION OF FLANGED COUPLING ADAPTERS:

A. Install flange coupling adapters in strict accordance with coupling manufacturer's recommendations.

3.04 INSTALLATION OF PIPE SUPPORTS:

A. Provide in accordance with Section 40 23 19.01.

B. Proceed with installation of pipe supports only after required building structural work has been completed and concrete has reached its 28 day compressive strength.

C. Support piping to prevent forces applied on valves and equipment.

3.05 PHYSICAL CHECKOUT, FIELD AND FUNCTIONAL TESTING:

A. Clean dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

B. Water for testing provided by the Contractor.

C. Pressure and Leakage Tests shall be done per C604:

1. Provide temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.

2. Test pipelines in sections of accepted length.

3. Fill section of pipe with water and expel air.

4. Pressure and leakage test consists of first raising pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.

5. No visible leakage in joint is acceptable.

6. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section has failed to pass test.

7. If section fails pressure and/or leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, and conduct additional tests and repairs until section passes test at no additional cost and without any time extensions.

D. Make piping connections to equipment with pipe in a free supported state and without application of vertical or horizontal forces to align piping with the equipment flanges.

3.06 FIELD PAINTING:

A. Provide in accordance with Section 09 91 13.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 40 23 19.03

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SECTION 40 23 19.04

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test ductile iron pipe, fittings and appurtenances as indicated and in compliance with Contract Documents.

B. Options:

1. For buried exterior pipelines provide push-on joint pipe.

a. Provide restrained push-on pipe as specified

b. Provide either restrained push-on joint fittings as specified and indicated or provide mechanical joint fittings with restraint system as specified herein

2. For piping exposed as in buildings and galleries, provide flanged or rigid-joint, grooved-coupled pipe and fittings.

3. Cast iron pipe and fittings are not acceptable.

1.02 REFERENCES

A. American Society of Mechanical Engineers (AMSE):

1. B16.1: Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

2. B16.21: Nonmetallic Flat Gaskets for Pipe Flanges.

3. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings.

4. B31.1: Power Piping.

B. ASTM International (ASTM):

1. A240: Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

2. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile.

3. A380: Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment and Systems.

4. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.

5. A774: Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.

6. A778: Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

C. American Water Works Association (AWWA):

1. A21.4: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. A21.10: Ductile-Iron and Gray-Iron Fittings, 3 in. through 48 in., for Water and Other Liquids.

3. A21.11: Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe Fittings.

4. A21.15: Flanged Ductile-Iron Pipe with Threaded Flanges.

5. A21.50: Thickness Design of Ductile-Iron Pipe.

6. A21.51: Ductile-Iron Pipe, Centrifugally Cast in Metal Molds, or Sand-Lined Molds, for Water or Other Liquids.

7. A21.53: Ductile-Iron Compact Fittings, 3-in through 16-in. for Water and Other Liquids.

8. C105/A21.5: Polyethylene Encasement for Ductile Iron Pipe Systems.

D. ISO:

1. 8179-1: Ductile Iron Pipes – External Zinc-Based Coating – Part 1: Metallic zinc with finishing layer. Second edition 2004-06-01.

E. Fluid Sealing Association: Technical Handbook.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Pipe manufacturer's technical specification and product data.

2. Certified shop and erection drawings. Contractor shall submit electronic files of the piping layout including the following.

a. Pipe layouts in full detail.

b. Location of hangers and supports.

c. Location and type of anchors.

d. Location of couplings and expansion joints.

e. 1/2-inch = 1 foot-0 inch (1 mm = 25 mm) scale details of all wall penetrations and special fittings.

f. Schedules of pipe, fittings, special castings, couplings, expansion joints and other appurtenances.

3. Certificates: Sworn certificates in duplicate showing compliance with material used and shop tests performed.

4. Catalog cuts and technical data for expansion joints, couplings, gaskets, pipe supports and other accessories.

5. Brochures and technical data on coatings and linings and proposed method of application.

6. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.

B. Material Certification:

1. Provide certification from the pipe and fittings manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

2. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

C. A copy of the contract mechanical process, civil and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.

C. Inspect and test at foundry according to applicable standard specifications.

D. Owner reserves right to inspect and test by independent service at manufacturer's plant or elsewhere at his own expense.

E. Visually inspect before installation.

F. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps and equipment to be installed in the piping systems.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

B. During loading, transportation and unloading, prevent damage to pipes and fittings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation.

PART 2 - PRODUCTS

2.01 PIPE:

A. Ductile Iron:

1. Design conforming to AWWA A21.50.

2. Manufacture conforming to AWWA A21.15 or AWWA A21.51.

3. Thickness class, unless otherwise indicated or specified:

a. Minimum Thickness Class 52.

b. Minimum thickness Class 53 for use with threaded flanges.

c. Minimum thickness Class 53 for use with flanged pipe.

d. Minimum thickness for use with grooved couplings conforming to AWWA C606.

4. Pressure Class, unless otherwise indicated or specified:

a. Minimum Pressure Class, 4-inches through 12-inches: 350

b. 14 inches through 64 inches: 250

c. Minimum thickness for use with grooved couplings conforming to AWWA C606.

2.02 PIPE FOR USE WITH COUPLINGS:

A. As specified above except ends shall be plain.

B. With bolted split sleeve couplings, ends cast or machined at right angles to axis.

C. With grooved type coupling:

1. Ductile-Iron of thickness class specified above.

2. Grooved End dimensions conforming to AWWA C606 for flexible or rigid joints to suit joint requirements.

2.03 FLEXIBLE JOINT PIPE:

A. Provide joints with maximum deflection 15 degrees in any direction from pipe axis. Joint design to prevent pulling apart, and to remain watertight at any deflection angle within specified range.

B. Provide boltless type with rubber gaskets.

C. Pipe barrel thickness: According to manufacturer's standard but not less than AN Standard for pipe of corresponding class.

D. Machine joint contact surfaces spherical, without depressions or chatter marks, or rough tool cuts.

1. Smooth by grinding, and buffing.

2. Machining accuracy: Finished pipes interchangeable without loss of watertightness or flexibility.

3. Protect spherical spigot and plain ends of cut lengths by fastened wood lagging.

2.04 FITTINGS:

A. Provide fittings conforming to AWWA A21.10 or AWWA A21.53, at least Class 150 and match piping class.

B. Provide all bell push-on or mechanical-joint fittings unless otherwise indicated or specified.

C. Face and drill flanged fittings conforming to AWWA A21.10 except special drilling or tapping for correct alignment and bolting.

D. If flanged fittings are not available under AWWA A21.10 provide fittings conforming to ASME B16.1 in 125 lb. pressure class.

E. Provide standard base fittings where indicated.

F. Provide grooved-end fittings ductile-iron conforming to AWWA A21.10 for center-to-face dimensions.

1. End preparation for grooved-ends conforming to AWWA C606 for flexible or rigid joints as required by type of joint.

2.05 NONSTANDARD FITTINGS:

A. Acceptable design.

B. Same diameter and thickness as standard fittings.

C. Manufactured to meet requirements of same specifications as standard fittings except for laying length and types of ends.

2.06 WALL CASTINGS:

A. Provide size and type indicated and specified.

1. Piping 24-inches and Smaller: Mechanical Joint with specified restraint or Restrained Push-On.

2. Piping 30-inches and Larger: Restrained Push-On.

B. Wall Castings: Conform to requirements of AWWA A21.10 or fabricate of Class 53 ductile iron pipe with screwed on flanges and welded on waterstop. Screwed on mechanical or push-on joints are not acceptable.

C. Provide water stop centered in wall. Weld water stops on in factory under controlled conditions to ensure adequate strength to permit waterstop to absorb thrust up to the pressure rating of the pipe.

Wall Castings with annealed ductile iron water stops	
Pipe Size	**Waterstop thickness, inches**
4 inch-12 inch	0.50
14 inch-24 inch	0.75
30 inch-36 inch	1.00
42 inch-48 inch	1.25

Wall Castings with fabricated steel water stops	
Pipe Size	**Waterstop thickness, in**
4 inch-16 inch	0.25
18 inch-24 inch	0.38
30 inch-36 inch	0.50
42 inch-48 inch	0.75
54 inch-64 inch	1.0

D. On flanged wall castings, provide space between the wall and flange to permit mounting the nuts on the flange bolts.

E. Flanged wall castings located with the flange flush with the wall are not acceptable.

F. Locate push-on joint wall castings with space between the bell and the wall to insert the follower bolts.

G. As an option, fabricated wall pipe of Schedule 40 Type 316L stainless steel may be substituted for wall castings specified above. Provide with waterstops of above dimensions and welded continuously on both sides of stop. Flanges of Type 316 stainless steel. Bolts for connection to buried pipe Type 316 stainless steel. Provide flange insulation gaskets, sleeves and washers for all flanges.

H. Testing: Factory pressure test all wall castings to pipe and joint pressure rating for a minimum of 5 minutes. No visible leakage is acceptable.

2.07 ADAPTERS:

A. Furnish and install for joining pipe of different types, unless solid sleeves indicated.

1. Provide ends conforming to above specifications for the correct type of joint, to receive adjoining pipe.

2. Joining two classes of pipe may be of lighter class provided annular space in bell-and-spigot type joints sufficient for jointing.

2.08 JOINTS:

A. Provide push-on joint and mechanical joint pipe with necessary accessories, conforming to AWWA A21.11.

1. Provide gasket composition designed for exposure to liquid within pipe.

B. Provide pipe flanges and accessories conforming to AWWA A21.15.

1. Provide flat faced flanges.

2. Provide 1/8-inch thick, full faced gaskets designed for exposure to liquid within pipe.

C. Provide restrained joint on pipe and fittings where indicated. Provide restrained joint which is:

1. Boltless

2. Capable of being deflected after assembly

3. Designs using set screws or requiring field welding are not acceptable.

4. Manufacturers:

a. American Cast Iron Pipe Co. Flex-Ring.

b. U.S. Pipe TR FLEX.

c. Clow Super-Lock.

2.09 MECHANICAL JOINT FITTINGS – RESTRAINT SYSTEM:

A. Provide restraint devices for pipe consisting of multiple gripping wedges incorporated into a follower gland meeting requirements of AWWA A21.10.

1. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, retaining full mechanical joint deflection during assembly and allowing joint deflection after assembly.

2. Provide actuation of the gripping wedges ensured with torque limiting twist off nuts.

3. Provide restraint devices Listed by Underwriters Laboratories (3 inch through 24 inch size) and Designed by Factory Mutual (3 inch through 12 inch size).

4. Gland body, wedges and wedge actuating components must be domestic manufactured in the USA.

B. Working Pressure Rating:

1. 16-inch and Smaller: 350 psi.

2. 18-inch thru 48-inch : 250 psi.

3. 54-inch (1400 mm): 200 psi .

4. Minimum safety factor: 2 to 1.

C. Materials:

1. Gland body, wedges and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.

2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN.

3. Provide three (3) test bars incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation in accordance with ASTM E8.

4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.

5. Provide an identification number consisting of year, day, plant and shift (YYDDD)(plant designation)(Shift number) cast into each gland body.

6. Record all physical and chemical test results such that they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTRs) available, in hard copy.

7. Provide coating for restraint devices consisting of the following:

a. Process all wedge assemblies and related parts through a phosphate wash, rinse and drying operation prior to coating application.

b. Coating: A minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat.

c. Surface pretreat all casting bodies with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. Coating: Polyester based powder to provide corrosion, impact and UV resistance.

d. Coating system: MEGA-BOND by EBAA Iron, Inc.

D. Manufacturer:

1. EBAA Iron MEGALUG Series 1100 or approved equal

2.10 FLANGE ADAPTORS:

A. Provide restrained flange adaptors for pipe consisting of multiple individual gripping wedges incorporated into a follower gland meeting requirements of AWWA A21.10.

1. Provide actuation of the gripping wedges ensured with torque limiting twist off nuts.

2. Provide restraint devices Listed by Underwriters Laboratories (3-inch through 12 inch size) and Designed by Factory Mutual (4-inch through 12-inch size).

3. Gland body, wedges and wedge actuating components must be domestic manufactured in the USA.

B. Joint Deflection capability:

1. 3-inch through 8-inch: 5 degrees

2. 10-inch and 12-inch: 3 degrees

3. 14-inch and 16-inch: 2 degrees

4. 18-inch and 20-inch: 1.5 degrees

5. 20-inch, 42-inch and 48-inch: 1 degrees

6. 30-inch and 36-inch: 3 degrees

C. Provide flange adaptor to maintain seal with and 0.6 inch gap between end of pipe and mating flange

D. Working Pressure Rating:

1. 16-inch and Smaller: 350 psi

2. 18-inch: 300 psi

3. 20-inch: 250 psi

4. 24-inch: 200 psi

5. 30-inch through 48-inch: 150 psi

6. Minimum safety factor: 2 to 1.

E. Materials:

1. Gland body, wedges and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.

2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN.

3. Provide three (3) test bars incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation in accordance with ASTM E8.

4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.

5. Provide an identification number consisting of year, day, plant and shift (YYDDD)(plant designation)(Shift number) cast into each gland body.

6. Record all physical and chemical test results such that they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTRs) available, in hard copy.

7. Provide coating for restraint devices consisting of the following:

   a. Process all wedge assemblies and related parts through a phosphate wash, rinse and drying operation prior to coating application.

   b. Coating: A minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat.

   c. Surface pretreat all casting bodies with a phosphate wash, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. Coating: Polyester based powder to provide corrosion, impact and UV resistance.

   d. Coating system: MEGA-BOND by EBAA Iron, Inc.

F. Manufacturer:

1. EBAA Iron MEGAFLANGE Series 2100 or approved equal

2.11 FLEXIBLE CONNECTIONS:

A. Use as specified or indicated:

1. Bolted split sleeve couplings

2. Grooved couplings

3. Expansion joints

2.12 BOLTED SPLIT SLEEVE COUPLINGS:

A. Provide in accordance with Section 40 23 19.04.

B. Pressure rating at least equal to that of related pipeline.

C. Provide with gaskets of composition designed for exposure to liquid within pipe.

2.13 GROOVED COUPLINGS:

A. Conform to AWWA C606.

B. Minimum pipe wall thickness specified under "Pipe For Use With Couplings."

C. Where grooved couplings are indicated to provide for expansion or flexibility, cut pipe grooves to provide necessary expansion or flexibility.

D. Where grooved couplings are used instead of flanged joints, joint to be of rigid type with pipe grooves cut to bring pipe ends together. Beam strength of joint shall be equal to or greater than that of flanged joint.

2.14 EXPANSION JOINTS:

A. Provide in accordance with Section 40 23 19.04.

B. Pressure rating at least equal to that of related pipeline.

2.15 FILLING RINGS:

A. Provide where necessary.

B. Materials, workmanship, facing, and drilling, conforming to 125-lb. ANSI (Class 125).

C. Suitable length with nonparallel faces and corresponding drilling, if necessary, for correct assembly of adjoining piping or equipment.

2.16 CONNECTIONS – TAPPED:

A. Provide service saddles for all taps for lines 24-inch and smaller.

1. Body: Ductile iron ASTM A395 or Bronze.

2. Straps and Hardware: Type 316 stainless steel.

B. For 30-inch and larger provide watertight joint with adequate strength against pullout. Use only tapered thread taps.

1. Maximum size of taps in pipe or fittings without bosses not to exceed that listed in table of Appendix to AWWA A21.51 based on: 2 full threads.

2. Where size of connection exceeds that given above for pipe, provide boss on pipe barrel or use tapping saddle. Make tap in flat part of intersection of run and branch of tee or cross, or connect by means of tapped tee, branch fitting and tapped plug or reducing flange, or tapping tee and tapping valve, or permitted.

3. Provide taps and piping for gauges and pressure sensing instruments in accordance with ANSI/HI standards so that there are no erroneous readings.

2.17 PIPE COATING:

A. Outside of pipe and fittings within structures: Clean and apply one shop coat with a 3 to 5 mil DFT of moisture cured urethane.

B. Outside surfaces of castings to be encased in concrete: No coating.

C. Machined surfaces cleaned and coated with rust-preventative compound at shop.

D. Outside of buried pipe and fittings:

1. Provide the exterior of all buried ductile iron pipe coated with a layer of arc-sprayed zinc in accordance with ISO 8179.

2. Mass of zinc applied: 200 g/m^2 of pipe surface area.

3. Provide a finishing topcoat applied to the zinc.

4. Provide the coating system conforming ISO 8179-1 “Ductile iron pipes - External zinc-based coating - Part 1: Metallic zinc with finishing layer. Second edition 2004- 06-01”.

2.18 CEMENT LINING:

A. Inside of pipe and fittings: Provide double thickness cement lining and bituminous seal coat conforming to AWWA A21.4.

2.19 GLASS LINING:

A. Glass Lining: Vitreous material that is smooth, continuous and formulated to prevent the adherence of grease, scum and crystalline metal salt deposits in sludge, scum and related process piping systems in wastewater and sewage treatment systems.

B. Provide lining consisting of two coats, separately applied and separately fired at a maturing temperature of approximately 1400 degrees F creating a molecular bond with the base metal and a total minimum lining thickness of 8-10 mils.

C. Lining minimum hardness: 5-6 on the MOHS scale.

D. Provide lining capable of withstanding an instantaneous thermal shock of 350 degrees F differential without crazing, blistering or spalling.

E. Provide lining capable of withstanding a strain of 0.001 inch/inch, the yield point of the base metal, without damage to the glass lining.

F. Provide lining resistant to corrosion of between PH-3 to 10.

G. Testing Procedure: In accordance with industry standards “MP-9.2 .1-Industry Continuity Test Procedures-Porcelain Enamel (Glass) Lined Pipe and Fittings”.

1. Acceptance Criteria:

Pipe Diameter	Maximum Pinholes/Fitting	Maximum Pinholes/ 20 Foot Pipe Length
8-inches and Smaller	3 to 5	10 to 12
10 to 18-inches	5 to 8	18 to 20
20-inches and Larger	8 to 10	25 to 28

H. The above criteria represents non-visible pinholes detectable by low voltage spark test only. Any pinholes that are visible to the naked eye and expose the base metal are not acceptable.

I. Factory test all pipe and fittings, with certified copies of the test results accompanying each shipment.

J. Provide documents identifying each individual item by mark number and description, the Quality Control Sequence Number, date tested, inspector, and the number of pinholes detected per item.

K. Fabricators:

1. Custom-Fab or approved equal

2.20 CERAMIC EPOXY LINING:

A. Material:

1. Amine cured novalac epoxy containing at least 20 percent by volume of ceramic quartz pigment, Tnemec 431 or approved equal.

2. Permeability rating: 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

3. Provide the following testing performed on coupons from factory lined ductile iron pipe:

4. ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.

5. ASTM G-95 Cathodic Disbondment 1.5 volts at 77 degree F. Results to equal no more than 0.5mm undercutting after 30 days.

6. Immersion Testing rated using ASTM D-714-87.

7. 20 percent Sulfuric Acid - No effect after two years.

8. 140 degrees F 25 percent Sodium Hydroxide - No effect after two years.

9. 160 degrees F Distilled Water - No effect after two years.

10. 120 degrees F Tap Water (scribed panel) - 0.0 undercutting after two years with no effect.

11. An abrasion resistance of no more than 3 mils loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

B. Lining Thickness:

1. 40 mils nominal dry film thickness. No lining shall take place when the substrate or ambient temperature is below 40 degrees F. The surface also must be dry and dust free.

2. Provide the number of coats of lining material as recommended by the lining manufacturer.

C. Preparation and Application: As recommended by the lining manufacturer

D. Lining Inspection:

1. Check all ductile iron pipe and fitting for thickness using a magnetic film thickness gauge using the method outlined in SSPC-PA-2 Film Thickness Rating.

2. Test the interior lining of all pipe barrels and fittings for pinholes with a nondestructive 2,500 volt test. Any pinholes found shall be repaired prior to shipment at no additional cost to the Owner.

3. Mark each pipe joint and fitting with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

4. Certification: The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, lining manufacturers recommendations for preparation and application and that the material used is as specified.

2.21 GASKETS, BOLTS, AND NUTS:

A. Provide ring or full face synthetic rubber gaskets for flanged joints and neoprene faced phenolic for insulating gaskets in accordance with AWWA A21.11 and ASME B16.21.

1. 1/8 inch thick.

B. Make flanged joints with:

1. Bolts.

2. Bolt studs with nut on each end.

3. Studs with nuts where flange is tapped.

4. Plastic bolt sleeves and washers for insulating joints.

C. Number and size of bolts conform to same ANS as flanges.

D. Provide Type 316 stainless steel bolts, washers and nuts for all services:

2.22 ELECTRICAL CONDUCTORS:

A. Provide 1/16-inch by 3/4-inch copper strip conductors for joints indicated to have electrical continuity.

B. Weld terminal strips to bell-ends and spigot ends of pipe in the foundry. Provide jumper strips and silicon bronze bolts and nuts to complete the connections.

C. If field cutting of pipe is necessary, weld terminal strip to cut spigot end using thermit weld or other designed process.

PART 3 - EXECUTION

3.01 HANDLING AND CUTTING:

A. Mark pipe and fittings "Rejected" and remove from site when cracked or has received a severe blow.

B. If permitted, cut on sound barrel at a point at least 12 inch from visible limit of crack, at Contractor's expense.

C. Machine cut with milling type cutters, knives, or saws. Snap cutters, torch, or hammer and chisel NOT ALLOWED. Examine for possible cracks.

D. Chamfer cut ends if used for push-on joints.

E. Do not cut glass lined pipes.

3.02 INSTALLATION:

A. Visually inspect before installation.

B. Ensure pipelines parallel to building walls wherever possible. Install piping to accurate lines and grades. Where temporary supports are used, ensure rigidity to prevent shifting or distortion of pipe. Provide for expansion where necessary.

C. Pitch piping toward low points. Provide for draining low points.

D. Before assembly, remove dirt and chips from inside pipe and fittings.

E. Piping Support: Provide in accordance with Section 40 23 19.01.

F. Pipe and Fittings:

1. Remove and replace defective pieces.

2. Clear of all debris and dirt before installing and keep clean until accepted.

3. Lay accurately to lines and grades indicated or required. Provide accurate alignment, both horizontally and vertically.

4. Provide firm bearing along entire length of buried pipelines.

5. Do not allow deflection of alignment at joints to exceed permissible deflection as specified below:

PIPE DEFLECTION ALLOWANCES

Maximum permissible deflection, inches* (mm)		
Size of pipe, inches (mm)	Push-on joint	Mechanical joint
4	19	31
6	1919	27
8	19	20
10	19	20
12	11	20

Maximum permissible deflection, inches* (mm)		
14	11	13-1/2
16	11	13-1/2
18	11	11
2024	11	11
30	11	9
3642	11	9
48	7-1/2	8
54	7-1/2	7-1/2
	7-1/2	7-1/2
		0
* Maximum permissible deflection for 20-feet (6.1 metres) lengths; for other lengths in proportion of such lengths to 20-feet (6.1 metres).		

a. For push-on joint or similar pipe, clean bell of excess tar or other obstruction and wipe out before inserting next pipe spigot. Shove new pipe into place until properly seated and hold securely until joint completed.

b. Set castings to be encased in concrete accurately with bolt holes, if any, carefully aligned. Clean off rust and scale before setting.

G. Temporary Plugs: When pipe laying not in progress, close open ends of pipe with temporary watertight plugs. If water in trench, do not remove plug until danger of water entering pipe passed.

H. Appurtenances: Set valves, fittings and appurtenances as indicated.

3.03 JOINTS AND COUPLINGS:

A. Push-on Joints:

1. Insert gasket into groove bell. Apply thin film of nontoxic gasket lubricant over inner surface of gasket in contact with spigot end.

2. Insert chamfered end into gasket. Force pipe past it until it seats against socket bottom.

B. Bolted Joints:

1. Remove rust-preventive coatings from machined surfaces.

2. Clean pipe ends, sockets, sleeves, housings, and gaskets and smooth all burrs and other defects.

3. Use torque wrench to tighten to correct range of torque not to exceed values specified below:

TORQUE RANGE VALUES		
Nominal pipe size, in	**Bolt diameter, in**	**Range of torque, ft-lb**
3	5/8	40-60
4-24, incl.	3/4	75-90
30, 36	1	100-120
42, 48	1-1/4	120-150

C. Flanged Joint:

1. Make up tight.

2. Do not put strain on nozzles, valves, and other equipment.

3. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.

D. Mechanical Joints:

1. Wire brush surfaces in contact with gasket and clean gasket.

2. Lubricate gasket, bell, and spigot with soapy water.

3. Slip gland and gasket over spigot, and insert spigot into bell until seated.

4. Seat gasket and press gland firmly against gasket.

5. After bolts inserted and nuts made finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint by torque wrench. Torque bolts to values specified above.

E. Flexible Joints:

1. Clean and dry before assembly.

2. Place gaskets, rings, glands and followers in position in back of spigot ball.

3. Coat ball and socket with thin film of lubricant conforming to joint manufacturer's standards.

4. Insert ball and seat in socket. Seat gasket against ball.

5. Boltless joints:

a. Assemble retainer rings and glands conforming to manufacturer's standard.

b. Lock in place with lead strips.

F. Grooved Couplings:

1. Clean grooves and other parts.

2. Coat ends of pipe and outside of gasket with soft soap or silicone and slip gasket over one pipe end.

3. Bring pipes to correct position and center gasket over pipe ends with lips against pipe.

4. Place housing sections, insert bolts and tighten nuts until housing sections in metal-to-metal contact.

5. After assembly and inspection and before backfilling, coat exterior surfaces of buried couplings, including bolts and nuts, with heavy-bodied bituminous mastic.

G. Tapped Connection:

1. Drill and tap normal to longitudinal axis.

2. Drilled by skilled mechanics using proper tools.

3. Use only tapered threads.

H. Electrical Conductors:

1. Install pipes so terminal strips are aligned.

2. Install jumper strips and tighten bolts.

3.04 POLYETHYLENE ENCASEMENT

A. Provide polyethylene encasement for use with ductile iron pipe in accordance with ANSI/AWWA C105/ A21.5, Polyethylene Encasement for Ductile Iron Pipe Systems.

B. Provide the polyethylene encasement for use with ductile iron pipe systems consisting of three layers of co-extruded linear low density polyethylene (LLDPE), fused into a single thickness of not less than eight mils.

C. Provide the inside surface of the polyethylene wrap in contact with the pipe exterior infused with a blend of antimicrobial compound to mitigate microbiologically influenced corrosion and a volatile corrosion inhibitor to control galvanic corrosion.

D. Install ductile iron pipe and the polyethylene encasement in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and also in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices – Ductile Iron Pipe and Fittings.

E. Overlap the wrap one foot in each direction at joints and secure in place around the pipe. Provide any wrap at tap locations taped tightly prior to tapping and inspected for any repairs following the tap and repair as required.

3.05 FIELD TESTING:

A. Provide in accordance with Specification Section 09 91 13.

B. Clean of all dirt, dust, oil, grease and other foreign material, before conducting pressure and leakage tests.

C. Pressure and Leakage Tests:

1. Conduct combined pressure and leakage test:

a. Initially on pipeline between first two valves, maximum length 1/4 mile, and within three days of completion.

b. Afterwards on completed sections of maximum length 1/2 mile.

c. Isolated sections upon completion.

2. Conduct combined pressure and leakage test in pipelines.

3. Furnish and install temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.

4. Test when desired and comply with specifications.

5. Test pipelines in excavation or embedded in concrete before backfill or placing of concrete and test exposed piping before field painting.

6. Fill section of pipe with water and expel air. If hydrants or blowoffs are not available at high points for releasing air, make necessary taps and plug after test completion.

7. Maintain section full of water for 24 hours before conducting combined pressure and leakage test.

8. Conduct pressure and leakage test consisting of first raising water pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to pipe pressure rating, but not more than 150 psi.

9. Maintain pressure and make leakage test by metering water flow into pipe. Acceptable results:

   a. Average leakage during test: less than 10 gallons per inch of diameter per 24 hours per mile.

   b. No visible leakage in joints.

10. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section fails test.

11. If section fails pressure and leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, at no additional expense and without time extension. Conduct additional tests and repairs until section passes test.

12. Modify test procedure only if permitted by Engineer.

3.06 FIELD PAINTING:

A. Provide in accordance with Section 09 91 13.

3.07 DISINFECTING AND FLUSHING:

A. Disinfect potable water lines using procedures and materials conforming to AWWA C651.

B. Dosage to produce minimum 10 ppm after minimum of 24 hour contact period.

C. After treatment, flush with clean water until residual chlorine content less than 0.2 ppm.

D. Prevent contamination of water in existing water mains. Neutralize chlorine content of water used in disinfecting and flushing accordance with AWWA C651.

3.08 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 40 23 19.04

SECTION 40 23 19.05

PROCESS PIPING AND APPUTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test process piping and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B16.1: AN Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

2. B16.3: Malleable Iron Threaded Fittings Classes 150 and 300

3. B16.5: AN Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

4. B16.9: Factory-Made Wrought Buttwelding Fittings

5. B31.1: Power Piping

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A47: Standard Specification for Ferritic Malleable Iron Castings

3. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

4. A105: Standard Specification for Carbon Steel Forgings for Piping Applications

5. A139: Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

6. A181: Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

7. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

8. A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

9. A197: Standard Specification for Cupola Malleable Iron

10. A216: Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service

11. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

12. A256: Standard Method of Compression Testing of Cast Iron

13. A269: Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service

14. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

15. A312: Seamless and Welded Austenic Stainless Steel Pipe

16. A351: Standard Specification for Castings, Austenitic, for Pressure-Containing Parts

17. A449: Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use

18. A536: Ductile Iron Castings

19. C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

20. C1136: Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

21. D256: Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

22. D570: Standard Test Method for Water Absorption of Plastics

23. D638: Standard Test Method for Tensile Properties of Plastics

24. D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between-30 Degree C and 30 Degree C with a Vitreous Silica Dilatometer

25. D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

26. D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

27. D1330: Standard Specification for Rubber-Sheet Gaskets

28. D1599: Standard Test for Short-Time Rupture Strength of Plastic Pipe, Tubing and Fittings

29. D2000: Rubber Products in Automotive Applications

30. D2105: Standard Test for Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube

31. D2412: Standard Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading

32. D3035: Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

33. D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

34. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

35. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

36. F1476: Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.

C. American Welding Society (AWS):

1. B3.0: Welding Procedure and Performance Qualification

D. American Water Works Association (AWWA):

1. C213: Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines

2. C219: Bolted, Sleeve-Type Couplings for Plain-End Pipe

3. C606: Grooved and Shouldered Joints

E. Expansion Joint Manufacturers Association Standards.

F. Fluid Sealing Association - Technical Handbook.

G. Manufacturer's Standardization Society (MSS):

1. SP-67: Butterfly Valves

2. SP-69: Pipe Hangers and Supports - Selection and Application

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Submit manufacturer's certificates of conformance.

2. Submit certified copies of test reports.

3. Piping layouts in full detail.

4. Location of pipe hangers and supports.

5. Large scale details of wall penetrations and fabricated fittings.

6. Schedules of all pipe, fittings, special castings, flexible connectors, adapters, couplings, expansion joints, and other appurtenances.

7. Reports as required for welding certifications per ASME B31.1 Paragraph 127.6.

8. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.

B. Grooved joint couplings and fittings: Provide product submittals with products specifically identified by the manufacturer's style or series designation.

1. Brochures and technical data on coatings and linings and proposed method for application and repair.

2. Manufacturer's descriptive literature and technical data on insulation and proposed method of installation.

3. Shop drawing data for accessory items.

4. Manufacturer's literature as needed to supplement certified data.

5. Operating and maintenance instructions and parts lists.

6. Schematic control and power wiring diagrams.

7. Shop and Field inspections reports.

8. List of recommended spare parts other than those specified.

9. Recommendations for short and long term storage.

10. Special tools.

11. Shop and field testing procedures and equipment to be used.

12. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and as indicated.

13. The latest ISO 9001 series certification or quality system plan.

14. Material Certification:

a. Provide certification from the piping and equipment manufacturers that the materials of construction specified are recommended and suitable for the service conditions specified and as indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified. And indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Authority.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

C. A copy of the contract mechanical process, civil, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required”.

1. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 QUALITY ASSURANCE:

A. Welder Qualifications:

1. Qualify and certify welding procedures, welders, and operators in accordance with ANSI B31.1, for shop and project site welding of piping work.

2. Qualification for welders: Welding shall be performed by welders holding current certification for the welding procedures in use.

3. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds for defects exceeding tolerances allowed by code under which the weld was made. Repair all defects exceeding tolerance.

B. Provide all grooved joint couplings, fittings, valves, and specialties to be the products of a single manufacturer. Grooving tools used must be of the same manufacturer as the grooved components.

1. Provide all castings used for coupling housings, fittings, and valve bodies date stamped for quality assurance and traceability.

C. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, and other equipment to be installed in piping system.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Section 01 66 10.

B. During loading, transportation and unloading, prevent damage to pipes and coatings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to protect pipe, lining, and coating.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE AND FITTINGS:

A. Provide in accordance with Section 40 23 19.04.

2.02 STAINLESS STEEL PIPE AND FITTINGS 2-1/2-INCH (65 MM) AND LARGER:

A. Provide in accordance with Section 40 23 19.02.

2.03 STEEL PIPE AND FITTINGS 10-INCH (250 MM) AND SMALLER:

A. Materials: Carbon steel, ASTM A53, Schedule 40, 80 or 120 black or galvanized as indicated in the Process Piping Schedule.

B. Joints:

1. Pipe 2-1/2 inch and smaller: Screwed joints using malleable-iron fittings, black or galvanized, to match pipe.

2. Pipe 3-inch and larger: Welded joints and butt-weld steel fittings.

3. Pipe 2-inch and larger: Grooved joints and fittings.

4. Provide flanged connections to equipment and valves with 150-lb. (Class 150) weld neck flat faced flanges.

5. Welding of pipe within classified areas in operation is not acceptable. Provide shop fabricated sub-assemblies and install with flanges or grooved-couplings as specified and indicated.

C. Fittings:

1. 2-1/2-inch and smaller: Screwed type, 150-lb. (Class 150) malleable iron, black or galvanized to match the pipe, ASTM A197 or A47, conforming to ASME B16.3. Unions of 150-lb. (Class 150) malleable iron with brass to iron seat.

2. 3-inch and larger: Butt welded carbon steel to match pipe wall thickness, ASTM A234, conforming to ASME B16.9 standards.

3. 2-inch and larger: Grooved end fittings; Ductile iron ASTM A536 Grade 65-45-12; Wrought steel ASTM A234 Grade WPB; or Factory-fabricated from steel pipe conforming to ASTM A53.

D. Grooved Joint Couplings: Provide couplings consisting of two ductile iron housing segments to ASTM A536, pressure responsive gasket to ASTM D2000, and Type 316 stainless steel bolts

and nuts. Provide couplings complying with ASTM F1476 Standard Specification for the Performance of Gasketed Mechanical Couplings for Use In Piping Applications.

1. Rigid Type: Provide coupling housings cast with offsetting angle-pattern bolt pads to provide joint rigidity and support and hanging in accordance with ANSI B31.1 and B31.9 or equal.

    a. Victaulic Style 107H, Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket, suitable for water service to +250 degrees F (121 degrees C).

    b. Victaulic Style 07 “Zero-Flex” or equal

2. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for the elimination of flexible connectors. Victaulic Installation-Ready Style 177 or Style 77 or equal.

3. 14-inch and Larger: AGS Series, with lead-in chamfer on housing key and wide width FlushSeal gasket. Victaulic Style W07 (rigid) and Style W77 (flexible) or equal.

E. Branch Connections:

1. 2-inch and smaller connections to welded pipe: Screwed, forged carbon steel, ASTM A105, 3,000-lb. half-couplings or welding saddle with threaded outlet.

2. 2-1/2-inch and larger pipe connections: Tees or reducing tees. Butt welded carbon steel to match pipe wall thickness, ASTM A181 GR1 or A105 GR1, conforming to ASME B16.1 standards.

F. Flanges: Forged steel, ASTM A181.

1. Slip-on or welding neck type as specified and indicated.

2. Provide 150-lb. (Class 150) flanges drilled and faced.

3. Raised face type: 1/16-inch raised faced in accordance with ASME B16.5.

4. Flat-face, welding neck type: ASME B16.1 Standard for all connections to valves and equipment.

5. Gaskets: For flanged joints, 1/16 inch thick suitable for the service specified and indicated.

6. Flange Adapters: Flat face, ductile iron housing with elastomer pressure responsive gasket, suitable for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741 / W741 or equal.

2.04 STEEL PIPE 12-INCH AND LARGER:

A. Provide in accordance with Section 40 23 19.03.

2.05 STAINLESS STEEL PIPE AND FITTINGS 1/2-INCH TO 2-INCH:

A. Provide either Pressfit, grooved or a socket welded system.

1. Provide a sufficient number of unions for Vic-Press and socket welded systems to allow removal of all valves and inline devices.

2. Provide threaded connections only where required.

B. Vic-Press Schedule 10S System:

1. Vic-Press system, 1/2-inch through 2-inch Schedule 10S comprised of stainless steel Vic-Press fittings, couplings and pipe.

2. Type 316 stainless steel Pressfit couplings and fittings and Type 316 stainless steel Pressfit pipe UL classified to ANSI/NSF 61 for cold +86 degrees F and hot +180 degrees F potable water service.

   a. Maximum working pressure of 500 psi for water, oil, gas, chemical, air and vacuum services.

3. Couplings, Fittings: Pressfit products formed of Type 316/316L stainless steel tubing including a self-contained o-ring seals molded of synthetic HNBR rubber suitable for water operating temperatures to +210 degrees F.

4. Valves 1/2-inch through 2-inch ball valves with Type 316 stainless steel plain ends for Pressfit assembly. Victaulic Series 569.

   a. Pressure Rating: 300 PSI.

   b. CF8M stainless steel body and ball

   c. Type 316 stainless steel stem

   d. PTFE seats.

5. Pipe: Type 316/316L ASTM A312 stainless steel

   a. Schedule 10S.

C. Socket Welded System:

1. Schedule 40 Type 316L stainless steel pipe and fittings with socket welded connections.

D. Grooved System:

1. Schedule 10S type 316L stainless steel pipe and fittings with Type 316 stainless steel grooved end connections and couplings.

2. Fittings: ASTM A403 or be factory fabricated from ASTM A312 stainless steel pipe.

3. Provide couplings consisting of ductile iron or stainless steel housings, with pressure responsive elastomer gasket.

   a. Rigid Type: Victaulic Style 489 (SS) or equal.

   b. Flexible Type: Victaulic Style 77S (SS) or equal.

c. Installation-Ready, for sizes through 4 inches, with ductile iron housings. Victaulic Style 107H (rigid) and Style 177 (flexible) or equal.

d. 14-inch and Larger: AGS Series, with lead-in chamfer on housing key and wide width FlushSeal gasket. Victaulic Style W89 (rigid) or equal.

2.06 HDPE PIPE AND FITTINGS:

Refer to Section 40 23 19.06 in addition to the information below.

A. Manufacturers:

1. Independent Pipe Products

2. J-M Manufacturing

B. Provide ductile iron pipe size high density polyethylene pipe and fittings.

1. Size range: 4-inch to 30-inch.

2. Working Pressure: 160 psi.

3. Joints:

a. Butt heat fusion.

b. Flanged: Provide at all equipment, valves, tanks and wall penetrations.

4. Flanged Connections: Van Stone type with HDPE flange and bolt ring as specified.

a. Bolt Torque: Install in accordance with Plasric Pipe Institute, Inc Technical Note #38.

5. Fittings:

a. 90 Degree Bends: Provide 5 piece HDPE segmented elbows.

b. 45 Degree Bends: Provide 3 piece HDPE segmented elbows.

c. Concentric Reducers: HDPE three section traditional type design, compact reducers are not acceptable.

d. For pump suction eccentric reducers provide flanged glass lined ductile iron or flanged Type 316L stainless steel as indicated.

e. Provide stiffeners where required.

C. Materials:

1. Pipe and Fittings: Material designation PE4710 in accordance with ASTM D3035 or PE3048 in accordance with ASTM D3350.

2. Bolt Rings: Type 316 stainless steel ASTM A531 Grade CF8M.

3. Hardware: Type 316 stainless steel.

2.07 CHEMICAL TUBING AND FITTINGS:

A. Manufacturers:

1. New Age Industries

2. Nalge lnc.

3. Norton CompanyTubing:

1. Provide braided reinforced flexible PVC tubing resistant to the chemical specified.

2. Tubing to allow tight compression fittings for leak proof connections.

3. Tubing to comply with FDA standards.

4. Tubing to handle a maximum of 130 psi at 70 degrees F.

C. Fittings:

1. Provide no flow restriction compression fittings when connecting pieces is required.

2. Provide transition connections as detailed on the drawings.

2.08 PRESSURE GAUGES:

A. Gauges:

1. Non-liquid filled type.

2. Helical wound bourdon tube, Inconel X-750.

3. Welded parts: Type 316 stainless steel.

4. Bearings: Precision Sapphire Type.

5. 1/2-inch NPT bottom male thread connection.

6. Accuracy: 1/2 percent of scale range.

7. 4-1/2-inch diameter with ABS plastic case.

8. Provide external adjustment.

9. Pipe and Fittings: Schedule 5 Pressfit or Schedule 40 threaded or socket welded, Type 316L stainless steel.

10. Pump Suction Gauges: Provide gauges with range to cover both the normal operating range and the range of pressures that will result from flushing.

11. Pump Discharge Gauges: Provide gauges with range to cover the normal operating range, above the pump shutoff head and the range of pressures that will result from flushing.

12. Seal Water Gauges: Provide gauges with range to cover both the normal operating range and the range of pressures that will result from flushing.

13. Double Wall Stainless Steel Expansion Joint Gauges: Provide gauges with ranges to suit process line pressure as specified and indicated for the service specified in the Process Piping Schedule.

B. Pipe and fittings: Type 316L stainless steel, provide as specified herein.

C. Ball valves: General service stainless steel ball valves in accordance with Section 40 23 13.01.

D. Pressure Sensor Rings:

1. 1-inch and Larger: Provide sensor/isolators that fit inside the bolt circle of 150-lb (Class 150) or 300-lb (Class 300) ANSI flanges as required.

2. 3/4-inch and Smaller: Provide sensor/isolators full flange or threaded as specified and indicated. For chemical system provide full flange, threaded connections are not acceptable.

3. Face to face length of the sensor: Conform to Specification MSS-SP67.

4. Type: Flow through design with flexible sleeve around full circumference. The center section shall have a cavity behind the sleeve filled with silicone fluid to transfer pressure to the gauge.

5. Rigidly support all pressure instruments by a post at least 7/8 inch diameter welded to the isolator. On sensor rings with more than one instrument, provide all connections 1/2-inch NPT as a minimum, 1/4-inch NPT fittings are not acceptable.

6. Provide sensor/isolator rings that do not have any fill plugs or valves that can be inadvertently removed with the resultant loss of fill fluid. Pressure sensor/isolators using valves are not acceptable.

7. Provide liquid filled sensor/isolators permanently vacuum sealed at the factory with a modular seal consisting of a membrane and needle fitting to allow removal and replacement of pressure instruments without compromising the vacuum fill. Sensor/isolators using valves are not acceptable.

8. Provide the needle fitting with both 1/4-inch NPT(F) threads and 1/2-inch NPT(M) threads.

9. Provide the pressure sensor/isolator capable of operating under pressure with all pressure instruments removed with no loss of fill fluid. Provide an intergral block valve, separate isolation valves are not acceptable.

10. Attach pressure instruments to the isolator with a hand tightened lock ring.

11. It shall be possible to remove or attach pressure instruments to the isolator without requiring the use of any tools.

12. Permanently fill the pressure sensor with high viscosity silicone instrument oil to damp out surges or pressure spikes without the requirement for a separate snubber.

13. Pressure rating: 200 psi minimum for all lines tested at 150 psi or less and 600 psi minimum per lines tested above 150 psi .

14. Provide gauges as specified herein. Provide all other types of instruments indicated and specified in accordance with Section 40 90 00.

15. Materials:

    a. Pressure sensor/isolator rings: Provide materials suitable for the service conditions specified and indicated, as a minimum provide the following

Service	Body & Plates	Sleeve
Water	Type 316L Stainless Steel	Natural Rubber
Wastewater	Type 316L Stainless Steel	Natural Rubber
Sludge	Type 316L Stainless Steel	Natural Rubber
Scum	Type 316L Stainless Steel	Natural Rubber
Septage	Type 316L Stainless Steel	Natural Rubber
Grit	Type 316L Stainless Steel	Natural Rubber
Sodium Hydroxide	Type 316L Stainless Steel	EPDM

2.09 PRESSURE AND FLOW INSTRUMENTATION:

A. Provide in accordance with Section 40 90 00.

2.10 WATER PRESSURE REGULATORS 1/2-INCH THROUGH 1-INCH:

A. Manufacturers:

1. Cashco

2. Watts

B. Provide water pressure regulators as indicated and specified. Provide sizes and flow rates as indicated and specified or as required by the equipment manufacturer.

C. Provide self contained units operated by internal spring loaded diaphragms or pistons.

1. Provide large size regulators of spring-opposed piston type where not available in diaphragm configuration.

D. Materials:

1. Body and Spring Chamber: ASTM A351 CF8M stainless steel.

2. Cylinder, Piston, Body Cap and Pusher Plate: Type 316 stainless steel.

3. Piston Ring: Inconel X-750.

4. Diaphragm: FKM

5. Seat Disc: V-TFE.

E. End Connections: NPT Female

F. Provide regulators constructed such that all repairs may be performed with valve in-line.

G. Furnish regulators with top adjusting screw provided to set downstream pressure.

H. Provide regulators sized for required flows with inlet pressure and outlet pressure as indicated and specified or as required by equipment manufacturer.

I. Pressure variation at outlet greater than 15 psig at maximum required flow is not acceptable.

2.11 COUPLINGS-SLEEVE TYPE:

A. Manufacturers:

1. Romac

2. Smith Blair

3. Viking Johnson

4. Dresser

B. Provide couplings meeting AWWA C219

C. Couplings 12-inch and smaller:

1. End rings and center rings: ASTM A536 ductile iron, fusion bonded epoxy coated

2. Gaskets: Buna-N, NSF 61 approved

3. Hardware: Type 316 stainless steel

D. Couplings 14-inch and larger:

1. End rings and center rings: ASTM A36 steel, fusion bonded epoxy coated

2. Gaskets: Buna-N, NSF 61 approved

3. Hardware: Type 316 stainless steel

E. Bridles and tierods: Minimum 3/4-inch diameter, except where tierods replace flange bolts of smaller size, in which case fit with nut on each side of pair of flanges.

1. Provide as indicated

2.12 COUPLINGS-BOLTED SPLIT SLEEVE TYPE:

A. Manufacturers:

1. Victaulic Depend-O-Lok

B. Type: Bolted, split-sleeve type coupling consisting of four basic components; one piece housing, gaskets assembly, bolts and nuts, and restraint rings as required for restraint.

1. Provide split-sleeve with a double arch cross section closing around pipe ends that are smooth for expansion or contraction requirements or pipe ends with end rings affixed for pipe end restraint requirements. As the coupling housing closes, it confines the elastomeric gasket beneath the arches of the sleeve to create the radial seal. The axial seal is affected by the sealing plate at the closure plates as the bolts pull the coupling housing snug around the pipe.

2. Provide sealing members comprised of two “O” ring gaskets and an elastomer sealing pad bonded to the integral sealing plate.

C. Provide couplings designed for the type, size, and working pressure of the piping system as indicated in the Process Piping Schedule and specified.

D. Materials:

1. Split-sleeve:

a. Carbon Steel and Ductile Iron pipelines: ASTM A36 Carbon Steel.

b. Stainless steel pipelines, ASTM A240 Type 316L stainless steel.

c. Provide stainless steel couplings where there is a transition for ductile iron to stainless steel piping.

2. Gaskets:

a. Material: Elastomers in accordance with ASTM D2000.

(1) Air Service: Silicone conforming to ASTM D2000 for air service up to 240 degrees F with intermittent exposure to 280 degrees F.

(2) Liquid Service: Isoprene or Buna-N conforming to ASTM D2000 for service within the temperature range of -20 degrees F to 180 degrees F.

3. Bolts and Nuts:

a. Bolts: Stainless steel conforming to ASTM F593 Type 316, minimum tensile strength 85,000 psi, (or threaded studs to ASTM A193, Class 2 Grade B8M Type 316)

b. Nuts: ASTM F593 Type 316.

4. End Restraint Rings:

a. Provide restraint rings of the same material as the coupling housing.

b. Non-restrained (ExE) type couplings allows for up to 4 degree deflection. Provides for coupling joint where restraint is not required. If restraint is required, it must be provided independent of the coupling.

c. Fixed x Expansion (FxE) type couplings: Allows for thermal expansion and contraction at the pipe joint. Provide one or two restraint rings fixed to one end of the pipe to keep coupling in the proper location. Where split sleeve coupling FxE for expansion is used provide the expansion side of the coupling with a combination of fixed and sliding supports for thermal movement.

d. Fixed x Fixed (FxF) type couplings: Provides a fully restrained pipe joint. Provide one restraint ring welded to each of the pipe ends fitting beneath the coupling to prevent the pipe joint from pulling apart.

e. Provide type as indicated and specified.

f. Follow manufacturer's written recommendations and instructions for location dimensions and welding detail required to attach the restraint rings.

E. Provide a Type 316 stainless steel nameplate welded to each coupling with the following data:

1. Manufacturer and date fabricated.

2. Type of Coupling (ExE, FxE, FxF).

3. Working Pressure in psi.

4. Test Pressure in psi.

5. Materials for coupling, hardware and gaskets.

F. Protective Coating: Prior to installation, couplings shall be coated on the I.D. and O.D. in accordance with section 09 91 10 and 09 91 13.

G. Couplings installed underground: Provide bitumastic coating or joint tape wrap.

H. Installation of couplings shall be in accordance with manufacturer's recommendation.

1. The coupling housing shall be assembled pulling the closure plates together with the bolts tightened to assure snug coupling housing contact with the pipe OD. Follow the manufacturer's recommendation regarding the installation and tightening of the bolts.

2.13 SAFETY SHIELDS-CHEMICAL SERVICE:

A. Provide shield type and materials for the service specified. Provide a written recommendation from the safety shield manufacturer.

B. Material: Non-porous teflon-impregnated glass cloth with a 5 mil thickness and sewn with 100 percent teflon thread and velcor closures and folded in a trifold design with an 0.82 mil teflon cord inserted on the sides to act as a draw string tying on the flange neck. Provide for use with 150 lb ANSI (Class 150) flanges.

C. Draw string or cord: 100 percent virgin unbleached teflon fiber.

D. Provide a clear leak indicating window with a pH paper insert that will change color to indicate a leak.

E. Provide shields with a working temperature rating of 93 degrees C and a working pressure rating of 200 psi.

F. Install safety shield for the following:

1. Expansion joints chemical services.

2. Flanged connections on chemical system pipe and fittings.

2.14 FLOW RATE INDICATORS:

A. Type: Rotometer with integral flow control valve.

B. Materials:

1. Polysulfone body with threaded ends,

2. Type 316 stainless steel float and guide.

C. Calibrate in gpm.

D. Accuracy +2 percent of full scale reading over 10:1 range.

E. Capacities as indicated. For pump seal water services provide with range as recommended by the pumping equipment manufacturer.

F. Working Pressure Rating: 150 psi.

2.15 HOSE, HOSE FITTINGS AND ACCESSORIES:

A. Hose Manufacturers:

1. Goodrich, HPD Industries

2. Goodyear

3. United Rubber Supply

4. Goodall

B. Hose: 1-inch:

1. Provide 4-ply rubber-lined and rubber-covered water hose for 150 psi working pressure.

2. Nozzle:

a. Shatter proof and UV resistant Lexan constant flow nozzle with bumper.

C. Hose Reels:

1. Type 316 stainless steel, mill finish.
2. Heavy duty square tubing frame.
3. Spring rewind with declutching arbor.
4. Stainless steel ball bearing swivel joint.
5. 1-inch female NPT.
6. 50 feet of hose.
7. Provide a flexible connector between the inlet pipe and inlet swivel joint.
8. Manufacturer: Hannay Model SS800 or acceptable equivalent product.

2.16 CHEMICAL HOSE AND FITTINGS:

A. Provide hoses that are suitable for suction and discharge application.

B. Materials:

1. Tube: Type T (FEP) Teflon with crosslinked polyethylene backing.
2. Reinforcement: Synthetic textile with steel helix.
3. Cover: EPDM.

C. Sizes:

1. 3/4-inch through 2 inch: 200 psi.
2. 2.5 and 3 inch: 150 psi.
3. 4 inch: 125 psi.
4. 3/4 inch through 4 inch: 30 in Hg vacuum.

D. Coupling: Provide type and materials as recommended by the hose manufacturer for the service conditions specified and indicated.

1. For sodium hydroxide provide flanged connection.

2.17 BASKET STRAINERS-CHEMICAL SERVICE:

A. Service Conditions:

1. Provide strainers suitable for the chemical service as indicated in the equipment schedules.
2. Provide size and type, simplex and duplex, as indicated.

B. Materials:

1. Body and Cover: CPVC

2. Valves for duplex strainers: CPVC

3. O-rings: EPDM or suitable for the service specified and indicated.

4. Baskets: CPVC with 1/16-inch perforations

C. Covers: Threaded with hand operable vent.

D. Body:

1. Provide with and operable drain.

E. Provide with integral flat mounting base.

F. Ball Valves for duplex strainers: Provide a 3-way ball valve at the inlet and outlet, mechanically connected with true-union connections.

G. Pressure Rating: 150 psi.

H. End Connections: Flanged 150 psi ANSI (Class 150) standard.

I. Duplex Strainer Configuration: Provide configuration as indicated.

2.18 INLINE SELF-CLEANING STRAINERS:

A. Type: Peripheral inflow design, self cleaning with cylindrical straining screens.

B. Straining Screens:

1. Media Type:

a. Perforated Screen or Wedge-Wire; Type and size as indicated in Strainer Schedule.

2. Material: Type 316 stainless steel.

3. Provide rigid scraper bars mounted adjacent to the screens.

C. Strainer Body: Cast Iron ASTM A278 Class 30:

1. Provide body with inline inlet and outlet, flanged, 150-lb (Class 150).

2. Provide factory hydrostatic testing of body at 150 percent of the maximum working pressure of the strainer.

3. Provide rigid scraper bars mounted adjacent to the screens.

4. Provide an inspection port and cover for access to the scraper bars for inspection and adjustment without disassembly or removal the strainer from the pipeline.

5. Provide a sump for solids removed from the flow stream.

6. Reject Valves:

a. Provide a 120 Volt, 60 Hertz, NEMA 4X electric motor operated ball valve operated by the control logic to flush solids from the strainer during the cleaning sequence.

b. Provide valves in accordance with Section 40 23 13.01.

c. Provide valve actuators in accordance with Section 40 23 13.03.

D. Motors:

1. Provide in accordance with Section 26 20 00 and as specified.

2. Service Factor: 1.15.

3. Insulation: Class F.

E. Controls:

1. Provide a NEMA 4X Type 316L stainless steel control panel with the following:

a. Disconnect.

b. Motor starters.

c. H/O/A switch. In the HAND position the screen drives and reject valve are actuated. In the AUTO position the screens operate and the reject valve open based on differential pressure. Provide a timer to allow setting of the time between cleaning cycles, adjustable from 1 minute to 24 hours.

d. Manual START momentary pushbutton to start a cleaning cycle.

e. Indicating lights: RED run and GREEN off.

f. High Pressure indication and alarm with automatic reset.

F. Provide a differential pressure device for strainer backwash control.

2.19 WALL AND FLOOR SLEEVES:

A. Materials:

1. Schedule 40 Type 316L stainless steel with 2-inch water stop welded both sides to prevent thrust movement and provide positive water sealing.

2. Schedule 40 carbon steel with 2-inch water stop welded both sides to prevent thrust movement and provide positive water sealing. Model GPWSW manufactured by Advance Products & Systems, Inc., or Equal

3. HDPE, 2-inch thru 24-inch and only where indicated and specified.

B. Water Stops: Provide water stops welded on both sides. Provide water stops 1/4-inch (6 mm) thick and 2-inch high and centered on the wall thickness.

C. Provide modular, mechanical type seals, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening.

1. Manufacturer:

a. Innerlynx

b. Or equal.

D. Provide the elastomeric elements sized and selected per manufacturer's recommendations and have the following properties as designated by ASTM. Coloration shall be throughout elastomer for positive field inspection. Each link shall have a permanent identification of the size and manufacturer's name molded into it.

E. Temperature Range: -40 to +250 degrees F.

1. Material: EPDM, ATSM D2000 M3 BA510

2. Color: Black

F. Modular seal pressure plates: Molded of glass reinforced Nylon Polymer with the following properties:

1. Izod Impact – Notched: 2.05ft-lb/in. per ASTM D256

2. Flexural Strength @ Yield: 30,750 psi per ASTM D790

3. Flexural Modulus: 1,124,000 psi per ASTM D790

4. Elongation Break: 11.07 percent per ASTM D638

5. Specific Gravity:1.38 per ASTM D792

G. Hardware: Type 316 stainless steel.

2.20 HYDRAULIC OIL SYSTEMS – PIPE AND FITTINGS:

A. Material: Type 316L stainless steel pipe in accordance with ASTM A312.

B. Working pressure: 2000 psi.

1. Provide pipe and fittings with a minimum safety factor of 6:1 based on maximum working pressure of the system.

2. SCH 40S/80S, minimum.

C. Joints:

1. Socket welded

2. Flanged and/or or deep socket weld flange where required at valves and equipment.

2.21 TRANSITION COUPLINGS:

A. Provide coupling in accordance with AWWA C219 as specified herein

B. Sizes: 2-inch through 24-inch.

C. Materials:

1. End rings and center rings: Ductile iron ASTM A536.

2. Gaskets: Virgin Styrene Butadiene Rubber(SBR) suitable for potable water and wastewater service, ASTM D2000 MBA 710.

3. Provide 5/8-inch, Type 316 Stainless steel bolts and nuts

D. Working Pressure: 250 psi.

E. Lining and Coating: Fusion bonded epoxy in accordance with AWWA C213.

2.22 DISMANTLING JOINTS:

A. Materials:

1. Flanged Spool: AWWA Class D steel ring flange compatible with ANSI class 125 and 150 bolt circles. Provide pipe of ASTM A36 plate 1 percent cold expanded to size.

2. End Ring and Body: ASTM A36 steel

3. Gaskets: ASTM 2000 Virgin NBR suitable for wastewater service

4. Bolts and Nuts: Type 316 stainless steel

5. Tie Rods: Type 316 stainless steel

B. Assembly Tolerance: 3 inches

C. Coating: Fusion bonded epoxy, NSF 61 certified

D. Pressure Rating: 150 psi working pressure

E. Manufacturers

1. Romac

2. Viking Johnson

2.23 INSULATION:

A. General:

1. Provide insulation where specified and indicated.

2. Provide pre-molded or pre-formed pipe insulation.

3. Provide insulation with a flame spread index of less than 25, and a smoke-developed index of less than 50 when tested in accordance with ASTM E84.

4. Provide insulation with a maximum thermal conductivity of 0.7 Btu-in/h-ft^2-degrees F at 75 degrees F mean temperature when tested in accordance with ASTM C177.

B. Insulation for systems with an operating temperature of 60 degrees F or higher:

1. Type:

a. Pre-Molded Fiberglass.

b. Provide All Service Jacket (ASJ) consisting of white draft paper bonded to aluminum foil with fiberglass reinforcement in accordance with ASTM C1136 Type 1.

c. Provide self sealing lap.

d. Provide insulation thickness as indicated on the Process Pipe Schedule.

2. Manufacturers:

a. Knauf Insulation.

3. Accessories:

a. Butt Strips: Provide self adhesive butt strips for sealing circumferential joints between insulation sections. Provide strips manufactured from white kraft paper bonded to aluminum foil with fiberglass reinforcement in accordance with ASTM C1136 Type 1.

b. PVC Fitting Covers: Provide pre-molded, insulated, white glass finish, suitable for inside and outside use. Provide fitting covers manufactured from PVC material having a flame spread index of less than 25, and a smoke-developed index of less than 50 when tested in accordance with ASTM E84, PVC material shall meet the requirements of ASTM D1784.

c. Vinyl Tape: Provide white, adhesive backed vinyl tape, minimum 1-inch wide for sealing PVC fitting covers to insulation.

d. Tacks: Provide white coated, stainless steel, barbed tacks.

e. Aluminum Protective Jacketing: Provide 0.020 inch Stucco Embossed Aluminum Jacketing.

f. Sound Barrier Jacketing: Provide a composite sound attenuating system comprised of an acoustic decoupler material laminated to 0.020 inch Stucco Embossed Aluminum Jacketing.

g. Stainless Steel Strapping: Provide Type 316 stainless steel strapping and wing seals. Provide strapping 1.2-inch wide or greater with a minimum thickness of 0.015-inch. Provide wing seals 1/2-inch wide or greater with a minimum thickness of 0.032 inches.

h. Sheet Metal Screws: Provide Type 304 stainless steel sheet metal screws.

C. Insulation for systems with an operating temperature below 60 degrees F.

1. Type: Pre-molded, Flexible Closed Cell Elastomeric Foam.

2. Provide self sealing lap for pipe sizes 6-inch and smaller. For pipe sizes above 6-inch and equipment provide Closed Cell Elastomeric Foam Sheets.

3. Manufacturers:

a. Armacell Engineered Foams, AP Armaflex SS and AP Armaflex.

4. Accessories:

a. Adhesive: Provide contact adhesive specifically designed for use with the insulation supplied.

b. Pipe support inserts: Provide a pre-fabricated insert designed to prevent damage to the insulation at the pipe support attachment point.

c. Provide an aluminum or stainless steel outer jacket, a foam inner core with plastic support and self sealing closure, or acceptable equivalent product.

2.24 STAINLESS STEEL HOSE AND FITTINGS:

A. Manufacturers:

1. Anamet, Inc Series 616

B. Provide corrugated stainless steel hose

C. Pressure Rating:

1. Maximum working pressure: Unbraided type

a. 3/8-inch and smaller: 250 psi

b. 1/2-inch: 60 psi

c. 3/4-inch to 1-inch: 40 psi

d. 1-1/4-inch: 20 psi

e. 1-1/2-inch: 15 psi

f. 2-inch to 3-inch: 10 psi

2. Maximum working pressure: Single braided type

a. 1/2-inch and smaller: 1000 psi

b. 3/4-inch to 2-inch: 450 psi

c. 2-1/2-inch to 4-inch: 300 psi

3. Safety Factor: 4:1

D. Material:

1. Core: Type 316

2. Braid: Type 316L stainless steel

3. Ends: Type 316L stainless steel

E. Ends: Provide type as indicated

1. 3/4 -inch to 3-inch: 150-lb (Class 150) welded female union end

2. 3/4-inch and larger: 150-lb (Class 150) flat faced floating flanged

2.25 SEAL WATER CONTROL AND MONITORING UNIT:

A. Manufacturer:

1. John Crane Safematic/Safeunit

B. Provide a single assembly to control and monitor seal water flow and pressure

1. Provide a flow rate indicator with memory pin

2. Provide a pressure gauge with memory pin

3. Provide a flow regulating valve

4. Provide an inductive low flow alarm and signal

5. Provide non-clog valves

6. Provide manual cleaning valve capable of operation while unit and pump is in service

7. Provide a pressure regulating valve

C. Pressure and Temperature Rating:

1. 150 psi

2. 360 psi

3. Maximum Temperature: 175 degrees F

D. Flow Range: Provide range suitable for system and as recommended by pump manufacturer.

2.26 CHEMICAL INJECTORS:

A. Manufacturer:

1. SAF-T-FLO

B. Provide assemblies consisting of the following components:

1. Brass corporation stop with safety device to prevent release of solution tube under line pressure of Type 316 stainless steel ball valve.

2. Type 316 stainless steel flange tapped to accept the corporation stop or ball valve.

3. Solution Tube of the length indicated with a locking device to prevent release of the tube under line pressure.

a. Ball check valve as specified in Section 40 23 13.03.

b. Type 316 stainless steel safety chain.

4. Chemical line connection to the assembly:

a. Provide a section of flexible tubing or hose suitable for the service conditions specified and indicated.

b. Isolation valve of the type indicated and specified.

2.27 SHOP PAINTING:

A. Provide in accordance with Section 09 91 10.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE:

A. Install pipelines parallel to building walls wherever possible. Install piping to lines and grades indicated and support. Where temporary supports are used, provide temporary supports as specified in Section 40 23 19.01 to prevent shifting or distortion of pipe. Provide for expansion.

B. Slope piping toward low points and provide for draining at low points.

C. Before assembly, remove debris from inside pipes and fittings.

D. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth burrs. Make up flanged joints tight, and prevent strain upon valves or other pieces of equipment.

1. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.

E. Install grooved joints in accordance with the manufacturer's written recommendations.

1. Grooved ends: Clean and free from indentations, projections, or roll marks.

2. Gaskets: Molded and produced by the coupling manufacturer of an elastomer suitable for the service pecified and indicated.

3. The coupling manufacturer's factory trained representative shall provide on-site training for the contractor's field personnel in the use of grooving tools and installation of product. The representative shall periodically visit the job site to ensure best practices in grooved product installation are being followed.

F. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system as indicated, and at changes in direction or other places to prevent joints from pulling apart under pressures indicated in the Process Pipe Schedule.

G. Examine pieces for damage. Do not install pieces that are damaged according to Engineer. If any damaged piece should be discovered after having been installed, remove and replace with a sound piece at no additional cost to the Authority.

H. Handle pipe with equipment such as nylon slings and padded skids, designed to prevent damage to the coating. Repair abrasions and injuries to the coating prior to the application of insulation or prior to the application of final field coating.

I. Support piping laid in trenches in trench on bed of selected backfill material which maintains desired line and grade.

J. Use dielectric bushings or unions when ferrous pipes join nonferrous pipes carrying liquid either underground or elsewhere.

K. Welding in accordance with AN Standard B31 and AWS B3.0.

3.02 WALL SLEEVE SEALS:

A. Expand rubber against pipe and sleeve by tightening bolts when assembled around pipe and inserted in wall.

3.03 TEMPORARY PLUGS:

A. Close open ends of pipe with temporary plugs or caps when pipe installation is not in progress. Use watertight plugs for exterior, buried piping and if water or debris is in trench when work is resumed, do not remove until adequate provision has been made to prevent any water or debris entering pipe even if it necessitates dewatering trench.

3.04 PHYSICAL CHECKOUT, FIELD AND FUNCTIONAL TESTING:

A. Clean dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

B. Water for testing provided by the Contractor.

C. Pressure and Leakage Tests:

1. Provide temporary testing plugs or caps; pressure pumps, pipe connections, meters, gages, equipment, and labor.

2. Test pipelines in sections of acceptable length.

3. Fill section of pipe with water and expel air.

4. Pressure and leakage test consists of first raising pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.

5. No visible leakage in joint is acceptable.

6. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section has failed to pass test.

7. If section fails pressure and/or leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, and conduct additional tests and repairs until section passes test at no additional cost and without any time extensions.

D. Make piping connections to equipment with pipe in a free supported state and without application of vertical or horizontal forces to align piping with the equipment flanges.

E. Do not cover joints in underground piping with backfill material until piping has successfully passed pressure test.

F. Test pressures as indicated in Process Pipe Schedule.

G. Repair faulty joints even to extent of disassembling and remaking joint, remove defective pipe and fittings and replace in manner satisfactory to the Owner.

3.05 FIELD PAINTING:

A. Provide in accordance with Section 09 91 13.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 40 23 19.05

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SECTION 40 23 19.06

HIGH DENSITY POLYETHYLENE PIPE

PART 1 - GENERAL

1.01 SCOPE

A. This described in this Section includes furnishing all labor, materials, pipe, fittings, butt fusion and incidentals required for installing a complete, leak-free high density polyethylene (HDPE) pipe. All piping under this section shall be installed and tested in accordance with these Specifications and the manufacturer's recommendations.

B. Related Work
Division 03 Concrete
Division 40 Piping and Appurtenances

1.02 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittals. Information to be submitted includes the following:

1. Manufacturer's Certification: Certify that products meet or exceed specifications.
2. Manufacturer's Quality Control Manual
3. Shop Test Results
4. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories.
5. Installation Instructions
6. Field Test Results

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State Laws as well as the latest editions of the applicable codes, standards, regulations or regulatory agency requirements including the following:

1. ASTM D638 Test for Tensile Properties of Plastics.
2. ASTM D790 Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
3. ASTM D1239 Test Method for Flow Rates of Thermal Plastics by Extrusion Plastometer.
4. ASTM D1248 Specification for Polyethylene Plastics Molding and Extrusion Materials.
5. ASTM D1505 Test Method for Density of Plastics by the Density Gradient Technique.
6. ASTM D1599 Test Methods for Short Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings.
7. ASTM D1693 Test Methods for Environmental Stress Cracking of Ethylene Plastics.
8. ASTM D2122 Method for Determining Dimensions of Thermal Plastic Pipe and
9. ASTM D2837 Method for Obtaining Hydrostatic Design Basis for Thermal Plastic Pipe

Materials.

10. ASTM D3035 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
11. ASTM D3350 Specification for Polyethylene Plastics Pipe and Fittings Material.
12. ASTM F1248 Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.
13. ASTM D4219 Test Method for Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
14. ASTM F714 Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter.

B. Quality and Workmanship

1. The pipe and fitting manufacturer's production facilities shall be open for inspection by the Engineer during normal working hours. During inspection, the manufacturer shall demonstrate that he has facilities capable of manufacturing the pipe and fittings required by this specification, that a quality control program meeting the minimum requirements of D3035, and ASTM F-714 is in use, and that facilities for performing the tests required by this specification are in use.

2. The Engineer may request certification that the pipe produced is represented by the quality assurance data. Additionally, test results from the manufacturer's testing which show the pipe does not meet appropriate ASTM standards of manufacturer's representation, will be cause for rejection of the pipe represented by the testing. These tests may include density and flow rate measurements from samples taken at selected locations within the pipe wall and thermal stability determinations according to ASTM D 3350, 10.1.9.

3. The Engineer may request certified lab data from the manufacturer to verify the physical properties of the materials supplied under this specification or at his own expense may take random samples for testing by an independent laboratory.

C. QA Deviations: Notify the Engineer if an approved supplier must supply material that does not meet all of the requirements of this specification. Submit a written description of any deviation, the justification for such deviation(s) and the worst case, long term impact of the deviation on the project. The Engineer shall decide if the material is acceptable. In the event that the Engineer rejects the deviation(s), the Contractor shall procure acceptable products at no additional cost to the Owner.

D. QA Rejection: Polyethylene pipe and fittings may be rejected in whole or in part by the specification Engineer for failure to meet any of the requirements of this specification.

E. QA Records: QA/QC records shall be maintained intact for a minimum of one year from the date of production.

F. Construction Practice: Construction and installation shall be performed in compliance with the manufacturer's Design Guidelines and Installation Guidelines, and this specification.

1.04 DELIVERY, STORAGE AND HANDLING

A. The manufacturer shall secure the piping such that shifting of the load in transit is not possible. The piping shall be covered for protection against weather and debris.

B. The Contractor and the Engineer shall inspect the pipe for defects prior to acceptance. Any

segments found to be damaged or unusable shall be returned to the manufacturer and replaced by new segments at no additional cost to the Owner.

C. The Contractor shall store the piping in an area not subject to regular traffic and out of direct exposure to sunlight. Any segments found damaged during installation shall be replaced by new segments at no additional cost to the Owner.

1.05 WARRANTY

A. The manufacturer shall provide a two (2) year warranty against defects in material and workmanship of all pipe segments.

B. The installation Contractor shall provide a three (3) year warranty against leakage at any joint.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. All HDPE pump station force main, drain and overflow pipes shall be PE 3408 DIPS. The sizes used in this design are based on the nominal size of DR 11 HDPE Pipe. See contract drawings for nominal sizes.

1. Pipe Working Pressure Rating: 160 psi.

2. Fitting Working Pressure Rating: 160 psi.

3. Joints: Butt heat fusion.

4. Fittings:

a. 45 Degree Bends: Provide 3 piece HDPE segmented elbows.

b. 22.5 Degree Bends: Provide 2 piece HDPE segmented elbows.

1. All HDPE force main outfall pipe shall be PE 3408 DIPS. The sizes used in this design are based on the nominal size of DR 11 HDPE Pipe. See contract drawings for nominal sizes.

1. Pipe Working Pressure Rating: 200 psi.

2. Joints: Butt heat fusion.

2. Table 1 gives the Pressure Class per AWWA C906, Pressure Rating and Allowable Total Pressure

During Recurring and Occasional Surge for PE3408 pipe at 80°F or less.

Pipe Dimension Ratio (DR)	Pressure Class	Pressure Rating	Allowable Total Pressure During Recurring Surge	Allowable Total Pressure During Occasional Surge
DR 11	160 psi	160 psi	240 psi	320 psi

A. Typical Physical Properties

Property	Specification	Units	Nominal Values
Material Designation	ASTM D-3350	-	PE3408
Material Classification	ASTM D-1248	-	III C 5 P34
Cell Classification	ASTM D-3350	-	345434C
Density (3)	ASTM D-1505	gm/cm^3	0.955
Melt Flow (4)	ASTM D-1238	gm/10 min	<0.14 @ 2.16 kg
Flex Modulus (5)	ASTM D-790	psi	135,000
Tensile Str. (4)	ASTM D-638	psi	3200
ESCR (3)	ASTM D-1693	F_o, Hrs	F_o> 5000
HDB @ 73 °F (4)	ASTM D-2837	psi	1600
U-V Stabilizer (C)	ASTM D-1603	%C	2.5
Hardness	ASTM D-2240	Shore “D”	64
Compressive Strength (Yield)	ASTM D-695	psi	1600
Tensile Strength @ Yield (Type IV Spec.)	ASTM D-638 (2"/min)	psi	3200
Elongation @ Yield	ASTM D-638	%, minimum	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D-638	psi	5000
Elongation @ Break	ASTM D-638	%, minimum	750
Modulus of Elasticity	ASTM D-638	psi	130,000
ESCR: Cond A,B,C: Mold. Slab)	ASTM D-1693	F_o, Hrs	F_o>5000
Compressed Ring (Pipe)	ASTM F-1248	F_{50}, Hrs	F_{50}>1000
Slow Crack Growth	Battelle Method	Days to Failure	F_o>32
Impact Strength (IZOD) (.125" THK)	ASTM D-256 (Method A)	In-lb/in Notch 42	
Linear Thermal Expansion Coef.	ASTM D-696	in/in/°F	1.2×10^4
Thermal Conductivity	ASTM C-177	BTU-in/ ft^2/hrs/°F	2.7
Brittleness Temp.	ASTM D-746	°F	<-180
Vicat Soft Temp.	ASTM D-1525	°F	+257
Heat Fusion Cond.	-	psi @ °F	75 @ 400°F
NSF Listing	Standard #14	-	“Listed”

Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high density ethylene/hexene copolymer PE 3408 polyethylene resin meeting the above listed physical property and pipe performance requirements:

1. The manufacturer shall provide certification that stress regression testing has been

performed on the specific product. The said certification shall include a stress life curve per ASTM D-2837. The stress regression testing shall have been done in accordance with ASTM D2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDR) of 160 psi, as determined in accordance with ASTM D 2837. The polyethylene pipe shall be provided with a minimum pressure safety factor of 150 percent.

2. The material shall be listed by PPI (the Plastics Pipe Institute, a division of the Society of the Plastics Industry) in PPI TR-4 with a 73 ºF hydrostatic design stress rating of 800 psi, and a 140 ºF hydrostatic design stress rating of 400 psi. The PPI Listing shall be in the name of the pipe manufacturer and shall be based on ASTM D 2837 and PPI TR-3 testing and validation of samples of the pipe manufacturer's production pipe.

3. The manufacturer's certification shall state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used, its source, and list its compliance to these specifications.

B. Pipe Extrusion

1. The pipe shall be extruded using a melt homogenizing/plasticating extruder and "appropriate" die. The extruder screw design should be customized for the HDPE being processed to minimize melt fracture of the molecular structure thus reducing the molecular weight and changing some physical properties from resin to pipe. The resin should be processed at its melt temperature of 375˚F to 425˚F. The extruded tubular melt will be vacuum or pressure sized in downstream cooling tanks to form round pipe to specification diameter and wall thickness with a "matte-finish" surface.

C. Pipe

1. Pipe supplied under this specification shall have a nominal DIPS (Ductile Iron Pipe Size) O.D. unless otherwise specified. Pipe shall have a DR of 11 unless otherwise specified.

2. The pipe shall be produced with the nominal physical properties outlined in Section 2.1(A), and to the dimensions and tolerances specified in ASTM F-714. Additionally, the pipe shall be inspected per industry accepted manufacturer standards for:

* Diameter
* Wall Thickness
* Concentricity
* Quick Burst Pressure and Ductility
* Joint Strength
* Straightness
* Ovality
* Toe-In
* Overall Workmanship
* Inspection on ID & OD
* Print Line

3. The pipe shall contain no recycled compound except that generated in the Manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogenous throughout and free of visible cracks, holes, voids, foreign inclusions, or other deleterious defects, and shall be identical in color, density, melt index and other physical properties throughout.

D. Pipe Performance

1. The pipe shall be in compliance with the physical and performance requirements of Section

2.1(A) of this specification. Specifically, the pipe will be extruded from resin meeting specifications of ASTM D 3350 with a cell classification of PE:345434C; and ASTM D-1248 pipe grade resin type III, Class C, Category 5, grade P34 polyethylene compound. The pipe shall exhibit the short term tensile and compressive physical properties listed in Section 2.1(A), and the pipe shall provide the long term endurance characteristics recognized by: the compressed pipe ring environmental stress crack resistance greater than 1000 hours; the slow crack growth resistance greater than 32 days; the impact strength (toughness) greater than 48 in-lb/in notch; and rotary fatigue endurance at ± 1600 psi bending stress with F_o>2000 cycles.

E. Fittings

1. The standard HDPE fittings shall be standard commercial products manufactured by injection molding or by extrusion and machining, or, shall be fabricated from PE pipe conforming to this specification. The fittings shall be fully pressure rated by the manufacturer to provide a working pressure equal to the pipe for 50 years service at 73.4˚F with an included 2:1 safety factor. The fittings shall be manufactured from the same resin type, grade, and cell classification as the pipe itself. The manufacture of the fitting shall be in accordance with good commercial practice to provide fittings homogenous throughout and free from crack, holes, foreign inclusions, voids, or other injurious defects. The fittings shall be as uniform as commercially practicable in color, opacity, density and other physical properties. The minimum “quick-burst” strength of the fittings shall not be less than that of the pipe with which the fitting is to be used.

2. Fittings shall be heat-welded.
3. All backing flanges for HDPE pipe flange connections will be hot dip carbon steel with 150 microns fft.
4. Care shall be taken when fastening HDPE flanged joints not to overstress the HDPE stub flanges. However, due to the properties of HDPE, tightening of the bolts will be done on multiple occasions over an extended period of time.

F. Manufacturers

1. ISCO Industries
2. Performance Pipe
3. Or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine tunnel before pipe placement to ensure:

1. No obstruction exists to interfere with installation.

B. Inspect each pipe and fitting before installation. Remove defective pipe. Replace with sound pipe.

3.02 PREPARATION

A. Pipe Packaging, Handling, Storage

1. The manufacturer shall package the pipe in a manner designed to deliver the pipe to the project neatly, intact, and without physical damage. The transportation carrier shall use appropriate method and intermittent checks to insure the pipe is properly supported, stacked, and restrained during transport such that the pipe is not nicked, gouged, or physically damaged.

2. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment. Pipes, fittings and coils shall be stored in such a way that they are completely protected from direct sunlight. Provide temporary shading. Covering causing temperature build-up is not acceptable. When covered they must be well ventilated to avoid accumulation of heat and resultant deformation. Transparent coverings shall not be used. The storage location shall be flat and shall, for pipes, support the pipes throughout their length. Stones and sharp objects shall not be present. Pipes shall not be stacked to a height exceeding 3 ft. The pipes must be secured at the sides to prevent them from rolling. Contact with harmful materials shall be avoided. As far as possible, coils shall be stored in a horizontal position. The area shall be free of stones and sharp objects. If stored upright they must be secured to avoid tilting.

3. Sections of pipe with cuts or gouges in excess of 10% of the wall thickness of the pipe shall be cut out and removed. The undamaged portions of the pipe shall be rejoined using the butt fusion joining method.
4. Fused segments of pipe shall be handled so as to avoid damage to the pipe. Nylon lifting slings are preferred. Spreader bars are recommended when lifting long fused sections. Care must be exercised to avoid cutting or gouging the pipe.

3.03 INSTALLATION

A. Joining

1. Sections of polyethylene pipe shall be joined above ground into continuous lengths at the job site. The joining method shall be the butt fusion method and shall be performed in strict accordance with the manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer, including, but not limited to, temperature requirements of 400 degrees F, alignment and 75 psi interfacial fusion pressure.

2. Butt fusion joining shall be 100% efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe. Flanges, unions, grooved-couplers, transition fittings and some mechanical couplers may be used to mechanically connect HDPE where approved in writing by the Engineer.

B. The Contractor shall use factory trained technicians to perform all butt welding. All installation technicians shall have installed HDPE pipe for a minimum of two (2) years.
C. Under no circumstances will pipes be welded or jointed when they are in their expanded state due

to the ambient temperature. Jointing will be done at the coolest of the day or when allowance has been made to accommodate sufficient contraction, without putting the pipe under unacceptable stress. This is especially related to HDPE pipes, but care must also be taken with other materials.

3.04 TESTING

A. Hydrostatic Tests

1. All pumps, gauges and measuring devices shall be furnished, installed and operated by the Contractor and all such equipment and devices and their installation shall be approved by the Engineer. All pressure and leakage testing shall be done in the presence of the Engineer.

2. The pipe shall be filled with water and subjected to a sustained pressure of 50 pounds per square inch. While the system is being filled, air shall be carefully and completely exhausted. If permanent air vents are not located at all high points, the Contractor shall install corporation stops or fittings and valves at such points so the air can be expelled as the pipe system is slowly filled with water.

3. Rate of loss shall not exceed that specified in the following paragraph "Allowable Limits For Leakage". Visible leaks shall be corrected regardless of total leakage shown by test.

4. Water for testing and flushing shall be potable water provide by the Owner from a source on site.

C. Allowable Limits for Leakage

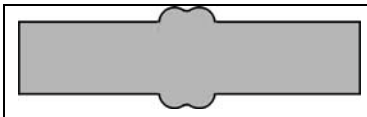
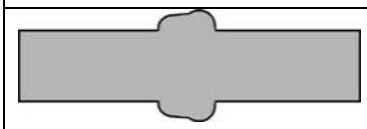
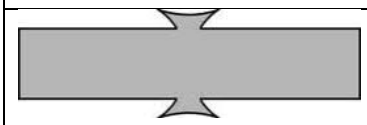
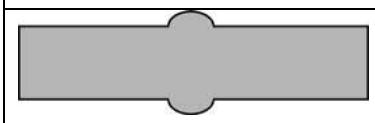
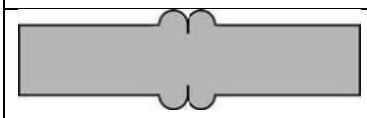
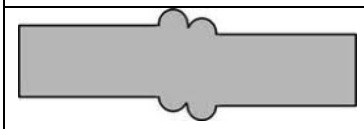
1. The hydrostatic pressure tests shall be performed to AWWA C-600 standards to ± 5 psi as herein above specified and no installation, or section thereof, will be acceptable until the leakage is less than the number of gallons per hour as determined by the formula:
in which,

$$L = SD\frac{\sqrt{P}}{133200}$$

L = Allowable leakage, in gallons per hour
S = Total linear feet of pipe tested
D = Pipe diameter; in inches
P = Average test pressure during the test, in psi gauge

3. Water shall be supplied to the main during the test period as required to maintain the test pressure as specified. The quantity used, which shall be compared to the above allowable quantity, shall be measured by pumping from a calibrated container.
4. HDPE Material Sample Bend Tests : At the start of each shift, or the change of installation crew, one sample butt weld shall be subjected to a bend radius test of t x 5, where t = piping wall thickness.

5. HDPE Butt Weld Visual Inspections : All HDPE butt weld will be inspected as follows:

	Correct welding.	✓
	The materials have different heating time and/or heating temperature.	X
	Welding bead narrow and high – too much pressure.	X
	Small welding bead – not enough pressure.	X
	Crack in the centre of welding bead – too low temperature, or long change over time.	X
	Misalignment – tolerance of 10% of pipe wall thickness acceptable.	X

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of paragraph 3.05.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

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SECTION 40 90 00 – INSTRUMENTATION AND CONTROL 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. Related Sections

1. Section 40 91 00 – Primary Process Measurement Devices
2. Section 40 91 13.29 – Ph Level Process Measurement Devices
3. Section 40 91 19.29 – Liquid Pressure Process Measurement Devices
4. Section 40 91 23.33 – Flow Process Measurement Devices
5. Section 40 91 23.36 – Level Process Measurement Devices.
6. Section 40 94 33 – Human-Machine Interface
7. Section 40 94 43 – Programmable Logic Process Controllers
8. Section 40 94 50 – Process Control Descriptions
9. Section 40 95 13 – Process Control Panels and Hardware
10. Section 40 95 73 – Process Control Wiring
11. Section 26 43 13 – Surge Suppression for Low-Voltage Electrical Power Circuits

1.2 SUMMARY

A. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place in satisfactory operation a complete Plant Monitoring and Control System (PMCS).

B. Work provided under this Section and Related Sections include final system design implementation, furnishing all components, system programming and configuration, system installation services, required support services, and complete documentation for the PMCS. Install all panels and designated instrumentation devices and provide all interconnections between the various components and their local sources of supply.

C. The intent of this Section is that the Contractor provide a complete and operational PMCS. Additional items of equipment, materials, or labor not specifically called for by these specifications, which may reasonably be considered to make the system complete and operational, shall be supplied as part of this work.

D. The system includes, but is not limited to, the following equipment:

1. Triplex Control Panel
2. SD-PLC
3. TOC analyzer
4. pH analyzers
5. Flow meters

1.3 DEFINITIONS

A. Abbreviations

1. CSI – Control Systems Integrator
2. HMI – Human Machine Interface
3. OIT – Operator Interface Terminal
4. P&ID – Piping and Instrumentation Diagrams
5. PLC – Programmable Logic Controller
6. PMCS – Plant Monitoring and Control System
7. PSI – Process Systems Integrator
8. RTU – Remote Terminal Unit
9. SCADA – Supervisory Control and Data Acquisition

B. Terms

1. CSI – A person or company that specializes in bringing together component subsystems into a whole and ensuring that those subsystems function together, a practice known as system integration. CSIs typically work for the Contractor but in some cases will work directly for the Owner.
2. HMI – Client software that requests data from a data acquisition server and is the graphical user interface for the operator, collects all data from external devices, creates reports, performs alarming, sends notifications, etc.
3. OIT – Computer hardware which presents processed data to a human operator, and through this, the human operator monitors and controls a process via HMI software. Examples of OITs are computer terminals and touchscreens.
4. P&ID – A diagram which shows the piping of the process flow together with the installed equipment and instrumentation. A P&ID also shows the interconnection of process equipment and the instrumentation used to control the process. In the process industry, a standard set of symbols is used to prepare drawings of processes. The instrument symbols used in these drawings are generally based on International Society of Automation (ISA) Standard S5. 1.
5. PLC – An industrial solid-state device that monitors and controls inputs & outputs and makes logic-based decisions for automated processes or machines.
6. PMCS – A term that references the overall plant control system and network including SCADA, DCS, PLCs, RTUs, remote & local controls, instrumentation, and communications.
7. PSI – Similar to the CSI with the exception that this person or company provides integration services specific to a single process such as the instrumentation/control system

for screening, degritting, or filtration. Each PSI works for their respective process equipment supplier/manufacturer.

8. RTU – A solid-state device that connects to instrumentation in a process and converts signals to digital data. RTUs have telemetry hardware capable of sending digital data to the supervisory system, as well as receiving digital commands from the supervisory system. RTUs often have embedded control capabilities such as ladder logic in order to accomplish Boolean logic operations.
9. SCADA – A networked computer system for remote monitoring and control that operates with coded signals over communication channels.

1.4 ACTION SUBMITTALS

A. General

1. Comply with the requirements specified in the General Conditions.
2. Procurement and installation of the PMCS shall not commence until related Submittals have been approved by the Owner & Engineer.
3. Submittals shall be submitted in complete packages grouped by Specification.
4. Review of Submittals will be for conformance with Contract Documents and with regard to functions specified.
5. Final and approved copies of all Submittals shall be provided in electronic form (e.g., *.pdf, *.dwg, etc.).

B. Submittal Requirements

1. Product information for all sensors/transducers and field and panel instruments. Include the following:

   a. Manufacturer's product name and model number.
   b. Instrument tag number from Contract Documents.
   c. Manufacturer’s standard catalog product data.
   d. Description of construction features.
   e. Performance and operation data.
   f. Installation and mounting details, instructions and recommendations.
   g. Service requirements.
   h. Dimensions.
   i. Range of each device and calibration information.
   j. Descriptions of materials of construction and a listing of NEMA ratings for all equipment.

1.5 INFORMATIONAL SUBMITTALS

A. PMCS Description

1. Detailed block diagram showing system hardware configuration and identifying model numbers of system components.
2. Software language and organization.

3. Format, protocol and procedures for data highway communications and local communications with input/ output modules and peripheral devices.
4. Human-machine interfacing details.
5. Control and failure modes.
6. On-line and off-line capabilities for programming, system utilities and diagnostics.
7. Input/output point listing with I/O module cross-reference identification for each distributed controller.
8. Data base listing including all input/output points.
9. Suggested detailed format and configuration of all log reports, alarm summaries, printer outputs, screen displays and graphics.
10. List of spare parts and test equipment.

B. Software Description

1. Standard technical documentation covering all aspects of the distributed control system software functions and capabilities, including instruction set description and programming procedures related to control, monitoring, display, logging, reporting and alarming functions.
2. Standard technical and instructional documentation covering software for utility, system support, system documentation, display, communications, data logging and storage and diagnostic functions.
3. Detailed functional descriptions of application programs explaining control, display, logging and alarming features to be provided and functions to be performed.
4. Documentation describing memory type, size and structure and listing size of system memory, I/O and Data Table memory and size of memory available for control programs. Also, define estimated control program memory requirements and processor execution times and program scan times to perform the display, logging, reporting and alarm functions required.
5. Documentation describing central monitoring station main and secondary memory types, size and requirements to perform the display, logging, reporting and alarming functions required.
6. Documentation for all PLC programming and HMI software configuration including features and capabilities, screen display and printout examples of a fully annotated and cross-referenced ladder diagram and the ladder diagram elements.
7. Documentation of all PLC programs including the databases to establish communication between the PLC and SCADA System that are provided independent of this Contract.

C. System Software Documentation

1. Prepare and submit two copies of preliminary software documentation at least four weeks prior to the expected initiation of factory testing and shall include the following as a minimum:

    a. Complete hard copies of all ladder diagram and function block programming. Documentation shall include complete external and internal I/O coil, contact and signal cross-referencing, addressing and rung numbering. Documentation shall clearly distinguish between internal and real I/O and shall also incorporate extensive

English language to identify contact, coil and signal functions and for labeling and description of program, sub-program and rung purpose and action.

b. Complete listing of external and internal I/O address assignments, register assignments and preset constant values along with functional point descriptions. Also, list all unused/undefined I/O and data table registers available.
c. Complete hard copies of all program documentation for all types of programs.
d. Detailed system memory map defining memory segments used and spare memory segments available for system memory, I/O tables, Data Tables and control program.
e. Complete database listing including listings for log, report and alarm file setups.
f. Hard copies of all system graphic displays and formats for all logs, reports and the alarm summary.
g. User's manuals describing procedures and providing examples for use of operator's consoles, workstations and programming terminal, accessories and system utility routines to perform control, display and logging program generation, program modification, program verification, diagnostics, program documentation, loading and backup and other required system support functions.

1.6 CLOSEOUT SUBMITTALS

A. Loop Diagrams

1. Prepare drawings on a module-by-module basis and include the following information:

a. Rack numbers, slot number, module type and module terminal point numbers. Also, include location and identification of all intermediate panel terminal block and strip numbers to which I/O wiring and power supply wiring is connected. Identify all power supply circuit numbers and ratings.
b. Wiring sizes, types, wire numbers and color-coding.
c. Location, functional name, tag numbers and manufacturer model numbers of panel and field devices and instruments to which I/O wiring is connected. For discrete I/O devices use NFPA 79 electrical symbols tagged with designation as shown.
d. Manufacturer’s data sheets and catalog literature.
e. Description of on-line diagnostic tests and off-line tests.
f. Dimensional data of equipment.
g. Addressing card and system layout, including special configuration rules and limitations.
h. Interface and cable data.
i. Hardware manuals.
j. Electrical characteristics and protection provided for each component.
k. Indicated modularity of I/O modules.
l. Manufacturer’s installation instructions for grounding and power conditioning requirements.
m. Description of how faults are detected, isolated and corrected.

B. Operation and Maintenance Manuals

1. Comply with the requirements specified in Section 01 78 23 “Operation and Maintenance Data”.
2. Control System Operations Manual.
3. Control System Maintenance Manual.
4. Laminated troubleshooting guides for both the operators and the maintenance staff.

C. Record Drawings and Documentation

1. Comply with the requirements specified in Section 01 77 00 “Contract Closeout”.
2. Contractor shall revise all system Shop Drawings, submittals and software documentation to reflect as-built conditions in accordance with the requirements of the Contract Documents and the supplemental requirements below.
3. Copies of all revised Shop Drawings and documentation shall be submitted to the Engineer to replace outdated drawings and documentation contained in the System Operation and Maintenance Manuals. Half-size black line sets shall be provided for all drawings larger than 11x17-inches. Specific instructions for outdated drawing removal and replacement shall be provided with the Record Drawing submittal.
4. Half-size black line prints of wiring diagrams applicable to each control panel shall be placed inside a clear plastic envelope and stored in a suitable print pocket or container inside each control panel.
5. Updated electronic copies of Record Drawings and Documentation will be provided in AutoCAD format or the original software. These drawings shall include loop sheets, system block diagrams, starter schematics, and P&ID drawings. The drawings shall indicate all wiring numbers.
6. The Contractor shall provide detailed documentation of all computer code developed for this project. This documentation shall include but not be limited to: flow charts, written descriptions, comments in PLC code, and HMI scripting. All software and code developed for this project shall be considered property of the Owner.
7. All As-Built documentation shall be provided in both paper and electronic formats

1.7 QUALITY ASSURANCE

A. General

1. The PMCS shall be furnished by a single integrator who shall assume responsibility for providing a complete and integrated system.
2. All required PMCS components, not provided by the PSI’s, shall be furnished by the CSI who shall assume the responsibility for adequacy and performance of all items.
3. The CSI shall supply its company's Quality Assurance Plan. The plan shall include, but not be limited to, the following:

    a. Method of testing
    b. Raw material criteria
    c. Methods of documentation
    d. Station control
    e. "Burn-In"
    f. Final tests

g. Serialization coding and packaging

B. CSI's Minimum Qualifications

1. Be a financially sound firm having at least five years continuous experience in designing, implementing, supplying and supporting instrumentation and control systems that are comparable to the PMCS in terms of hardware, software, cost and complexity.
2. A Professional Electrical Engineer, registered in the state of Georgia, shall be required to document the results of the control panel testing. The documentation shall contain the results of the tests listed above as well as any rework items and subsequent repairs that were required prior to shipment. In addition, the Professional Engineer must certify this document prior to the release for shipment. Prior to shipment, one copy of the applicable documentation shall be placed in the drawing pocket of each enclosure, and three copies shall be sent to the Engineer.
3. Have supplied and successfully installed standard lines of digital processing and control equipment and application software continuously for the last five years.
4. Have in existence at the time of bid, an experienced engineer and technical staff capable of designing, implementing, supplying and supporting the PMCS and handling the PMCS submittal and training requirements.
5. Provide system hardware components and software packages of fully developed, field proven standardized designs and therefore shall furnish a system that is not a highly unique, custom one-of-a-kind system.
6. Have a minimum of five years' experience in hardware application and programming of distributed microprocessor based controllers and data highway systems.
7. Provide standard course offerings in general process control applications and in operation, programming and maintenance of the control system and equipment at a facility specifically utilized for training purposes. The facility shall have been in operation continuously for the last two years.
8. Have a thorough working knowledge of wastewater treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.
9. Have a system of traceability of the manufactured units and purchased components through production, assembly and testing.
10. Have a system of "Burn-In" for all components and available supportive documentation.
11. Have a demonstrated record of prompt response to field failures.
12. Have a documented program of failure analysis.
13. Have or will use a UL approved panel shop.
14. Have a record of prompt shipments in accordance with contract obligations required for previous projects.

C. Reference Standards

1. The following organizations have generated standards that are to be used as guides in assuring quality and reliability of components and systems; govern nomenclature; define parameters of configuration and construction, in addition to specific details in the Contract Documents:

   a. The Instrumentation, Systems and Automation Society, (ISA)
   b. National Institute of Standards and Technology, (NIST)

c. Underwriters' Laboratories, Inc., (UL)
d. American Water Works Association, (AWWA)
e. National Electrical Manufacturer's Association, (NEMA)
f. Occupational Safety and Health Administration, (OSHA)
g. American National Standards Institute, (ANSI)
h. National Fire Protection Association, (NFPA)
i. Scientific Apparatus Manufacturer's Association, (SAMA)
j. National Fire Protection Association 79, Annex "D" Standards, (NFPA)
k. Institute of Electrical and Electronic Engineers, (IEEE)
l. National Electrical Code, (NEC)
m. Factory Mutual

D. Subject to compliance with requirements, available integrators offering services and products that may be incorporated into the Work include, but are not limited to, the following. Integrators not listed will be evaluated based on the requirements listed in Paragraph B.

1. Revere Control Systems, Birmingham, Alabama
2. M/R Systems, Norcross, Georgia
3. Transdyn Controls, Norcross, Georgia
4. Industrial Control Systems, Sandston, Virginia
5. GE Automation Services, Charlotte, North Carolina
6. Turbitrol Company, Lithia Springs, Georgia
7. Curry Controls Company, Roswell, Georgia
8. Control Instruments, Inc., Marietta, Georgia
9. C2i, Smyrna, Georgia

1.8 FIELD CONDITIONS

A. Delivery, Storage, And Handling

1. Computers and computer network equipment shall be packaged at factory prior to shipment for protection during shipment and storage. Containers shall be protected against impact, abrasion, corrosion, discoloration, and other damage. Clearly label contents of each container and information on storage conditions required.
2. Inspect all boxes, crates, and packages upon delivery to Site and notify Engineer in writing of loss or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with Supplier's instructions.

B. Storage and Protection

1. Prior to shipping materials and equipment from factory, CSI shall notify Contractor in writing of storage requirements and recommendations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

3.1 INSTALLATION

A. The CSI shall assign a full time representative to provide coordination and supervision of onsite I/C construction work. The individual is to be on site during all times when I/C work is being done.

B. The system, peripherals, and accessory equipment shall be installed in accordance with the manufacturer's instructions and located as shown on the Drawings unless otherwise approved by the Engineer.

C. All work shall be executed in full accordance with all applicable codes and local rulings. Should any work be performed contrary to said rulings, ordinances, or regulations, the CSI shall bear the full responsibility for such violations and assume all costs arising therefrom.

D. The Contractor shall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the manufacturer shall ship the equipment in sections sized to permit passage through such areas.

3.2 SYSTEM NOISE REJECTION

A. Electrical isolation shall be provided between input systems and the processor units. Noise rejection for common mode shall be at least 100 decibels from 0 to 100 Hertz, and up to 175 volts. Normal voltage rejection shall be not less than 35 decibels at 60 Hertz.

B. All instrument signal wiring, control wiring and AC control power wiring shall be protected against lightning, spikes, and other transient surges at all field and control panel termination points per the requirements of Section 26 43 13 “Surge Suppression for Low-Voltage Electrical Power Circuits”.

3.3 GROUNDING

A. Bond all instrument and control panel enclosures to the power system ground.

B. Ground analog signal conductor shields at the control panel end only.

3.4 TESTS AND ACCEPTANCE

A. The equipment and programs shall be factory-tested prior to shipment for compliance with the conditions of this section, these specifications, and for environmental conditions.

B. Factory Testing: Factory-test setup shall demonstrate peripheral performance, including all displays and graphics. All discrete and analog points shall be verified. A 100-hour burn-in test shall be performed on all solid-state devices. The Owner and/or Engineer reserves the right to witness the factory tests. At least 20 days written notice shall be given to the Owner and the Engineer by the Contractor prior to the date of starting factory tests. Submit detailed witness test and final checkout procedural outlines for approval to the Engineer not less than 60 days prior to starting factory tests. Testing shall include the complete system with all cabinet doors in place and peripherals attached, for an agreed to period of time, with documentation via periodic printouts.

C. After installation of the complete system, the Contractor shall provide the services of a qualified systems engineer to test the complete system under the observation of the Owner or Owner's representative to verify that all functions specified are performed without error or malfunction. As a part of the test procedure, Contractor's personnel, when requested by the system supplier, shall cause each remote process to change state or value three times to verify all functions during the checkout period. This shall be repeated until the system performs correctly to the satisfaction of the Owner or Owner's representative.

3.5 START-UP ASSISTANCE

A. The Contractor shall provide onsite services for a minimum of one week (5 days at 8-hours per day) for start-up assistance. The individual provided shall be familiar with the Project and with all software packages and supplied hardware. This individual shall be capable of modifying PLC programming or operator interface configuration during the start-up period.

3.6 TRAINING

A. The cost of training programs shall be included in the Contract Price. The training and instruction shall be directly related to the PMCS being supplied.

B. The Contractor shall provide the following training courses for designated Owner's personnel. The courses shall be taught by professional, full-time instructors. All course materials required to adequately support the material presented shall be included. The Contractor shall bear the cost of student transportation, meals, and lodging for any courses taught away from the Owner's facility. The Contractor shall set the schedule for all courses with the Owner at least 20 days prior to the proposed date.

1. PMCS Hardware Maintenance

    a. Length: Four hours
    b. Number of Students: 5
    c. Location: Owner's plant site
    d. This course will instruct the computer maintenance personnel in maintenance and repair practices used to support the system hardware.

2. Operator Familiarization

a. Length: Eight hours
b. Number of Students: 5
c. Location: Owner's plant site
d. This course will be taught on-site to ensure that plant operating personnel will be thoroughly familiar with the PMCS as delivered. The students will be instructed in PMCS start-up and loading procedures, loop tuning via the operator's console, and all computer features.

3. Report Generation Software

a. Length: One day
b. Number of Students: Three
c. Location: Owner's plant site
d. This course will provide the student with a working knowledge of the software used to generate custom reports. Topics shall include data storage, data retrieval including queries, report layout, and automatic report generating and printing for daily, weekly, and monthly reports. Include lab sessions to reinforce classroom lessons.

C. In addition to the courses enumerated above, the Contractor shall provide training courses taught by the equipment and software manufacturers, or their certified training provider, for the Owner’s personnel as follows. The courses shall be purchased in the names of the individuals designated by the Owner. The Owner will bear the cost of student transportation and boarding.

1. Wonderware

a. Provide two individual Industrial SQL Clients training passes for the Owner’s personnel. This course shall provide ActiveFactory training including trending, live and historical data retrieving and displaying, and report generating.
b. Each pass shall serve as tuition for one individual in the specified course taught at InSource Software Solutions in Duluth, Georgia, 770/935-9364.
c. The passes shall be valid for a minimum of 12 months from the date of purchase.

END OF SECTION 40 90 00

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SECTION 40 91 00 – PRIMARY PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all primary sensors and field instruments shown and specified herein.
2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, electrical conduit, piping and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, electrical conduit, accessories and labor required for a complete, workable, and integrated system.
3. Contractor shall be responsible for installing in-line flow elements (magnetic flow meter flow tubes, insert flow tubes) and for providing taps in the process piping systems for installation of other flow, pressure, and temperature sensing instrumentation.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

1.3 DEFINITIONS (NOT USED)

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 Instrumentation and Control for Process Systems.

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 Instrumentation and Control for Process Systems.

1.7 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 90 00 – Instrumentation and Control for Process Systems.

B. Acceptable Manufacturers

1. Furnish primary process measurement devices by named manufacturers or equal equipment by other manufacturers.
2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
3. Obtain all sensors and field instruments of a given type from the same manufacturer.
4. The primary sensors and field devices shall be interchangeable with similar function existing primary sensors and field devices to minimize spare parts inventory.

C. Manufacturers' Responsibilities and Services

1. Design and manufacture the primary sensors and field instruments in accordance with the applicable general design requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”, and the detailed Specifications herein.
2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 40 90 00 “Instrumentation and Control for Process Systems”.

1.8 FIELD CONDITIONS

A. Product delivery, storage and handling

1. Comply with the requirements specified in Section 40 90 00 Instrumentation and Control for Process Systems.
2. Primary sensors and field instruments shall not be delivered to the Site until all product information and system Shop Drawings for the sensors and instruments have been approved by the Engineer and Owner.

1.9 CHEMICAL SERVICE

A. Where a primary element is designated for chemical service, all wetted components and appurtenances for that primary element shall be resistant to corrosion by that chemical. Chemicals commonly referred to as, "sodium hypochlorite" and "polymer" shall mean the following:

1. "SODIUM HYPOCHLORITE": Sodium Hypochlorite (NaOCl), 15 percent solution, Specific Gravity = 1.23.
2. "POLYMER": Polymer Solution, 0.2 to 0.5 percent solution, Specific Gravity = 1.00.
3. "FERRIC CHLORIDE": Ferric Chloride (FeCl3), 43 percent solution, Specific Gravity = 1.46.
4. "CAUSTIC": Sodium hydroxide (NaOH), 50 percent solution, Specific Gravity = 1.53.
5. "HYDROCHLORIC ACID": Hydrochloric Acid (HCl), 38 percent solution, Specific Gravity = 1.4.
6. "METHANOL": Methanol (CH3OH), 99 percent solution, Specific Gravity=0.792.
7. “SODIUM BISULFITE”: Sodium Bisulfite (NaHSO3), 37 percent solution, Specific Gravity = 1.3

1.10 IDENTIFICATION TAGS

A. Performance Requirements

1. Tag numbers of sensors and field instruments shall be as shown and as specified. For items not shown or specifically tagged, the item tag number shall be established by the CSI. All instruments, whether field or panel mounted, shall have an identification tag.
2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.
3. The tags shall be fastened to the device with self-tapping stainless steel screws. Where fastening with screws cannot be accomplished the tags shall be permanently attached to the device by a circlet of stranded stainless steel wire rope and clamp.
4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel.

B. Construction Features

1. Tags shall be engraved with 3/16-inch letters and constructed as follows.

   a. 3/32-inch thick laminated phenolic for engraving composed of core, laminated on both sides with a matte (non-glare) finish cover sheet.
   b. Core to be black; cover sheet to be white.
   c. Mounting holes to be centered on width and 1/4-inch from each end.

1.11 FILLING LIQUID

A. Use silicone oil except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Flurolube 63.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Phoenix Contact
2. Turck
3. Or equal

2.2 PROCESS TAPS, SENSING LINES AND ACCESSORIES

A. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters

1. Material: Copper Water Tube, ASTM B-88, Type L, drawn temper or annealed.
2. Pressure Rating: 150 psi.
3. Size: 1/2-inch O.D. for water.
4. Connections: Brass Compression Type, "Swagelok" by Crawford, or equal.
5. Shut-off Valves

    a. Type: Ball.
    b. Pressure Rating: 150 psi.
    c. Body and Stem: Brass.
    d. Ball: Stainless Steel
    e. Packing: High Density TFE.
    f. Handle: Steel.
    g. Support Rings: TFE coated brass.
    h. End Connections: Removable "Swagelok", or equal.
    i. Model: NIBCO, Apollo or equal.

6. Manifolds

    a. Type: 5-valve and 3-valve meter manifolds.
    b. Materials: Type 316 stainless steel body, bonnets and stems; delrin seats; teflon packing.

B. Air Pressure Sensing Lines and Accessories for Air Flow/Pressure Transmitters

1. Material: Type 316 stainless steel tubing, ASTM A269, medium wall thickness.
2. Pressure Rating: 150 psi.
3. Size: 3/8-inch O.D. for air.
4. Connections: Type 316 stainless steel compression type, "Swagelok" by Crawford, or equal.
5. Shut-off Valves

    a. Type: Ball.
    b. Pressure Rating: 150 psi.
    c. Body, Ball and Stem: Type 316 stainless steel.
    d. Packing: High density TFE.
    e. Handle: Nylon with metal travel stops.
    f. Support Rings: TFE coated Type 316 stainless steel.

g. End Connections: Removable "Swagelok", or equal.

6. Manifolds

a. Type: 5-valve and 3-valve meter manifolds.
b. Materials: Type 316 stainless steel body, bonnets and stems; delrin seats; teflon packing.

C. Pressure Tap Sensing Lines and Accessories for Pressure Gauges and Pressure Switches

1. For Process Sensing Taps in Ductile Iron, Steel and Stainless Steel Piping Systems

a. Material and Fittings: Type 316 stainless steel pipe (ASTM A 312) and threaded fittings and adapters (ASTM A 403).
b. Sizes: 1/2-inch minimum for main sensing piping and 1/4-inch gauge and switch connections.
c. Pressure Rating: Equal to or greater than the applicable system test pressure.
d. Accessories

1) For applications not requiring diaphragm seals, provide separate 1/2inch Type 316 stainless steel threaded ball valve for each gauge and switch.
2) For applications requiring diaphragm seals, provide a separate 1/2-inch threaded Type 316 stainless steel ball valve for seal process side shutoff.

2. For Process Sensing Taps in Copper and Thermoplastic Piping Systems

a. Pipe Material and Fittings: Use same type of pipe material and fittings as that used in the process piping system.
b. Sizes: 1/2-inch minimum for main process sensing piping and 1/4-inch for gauge and switch connections.
c. Pressure Rating: Equal to or greater than the applicable system test pressure.
d. Accessories

1) For copper piping system taps with or without seals, provide a separate 1/2-inch minimum threaded brass or bronze ball valve for each gauge and switch.
2) For PVC piping systems with or without diaphragm seals, provide a separate 1/2-inch threaded ball valve for process sensing line shutoff.

2.3 INTRINSIC SAFETY DEVICES

A. General

1. Intrinsic Safety Isolators shall integrate transformer isolation, intrinsic safety barrier circuits, signal conditioning and diagnostic capabilities into one device. Device shall eliminate noise, ground loop problems and provide intrinsic safety without a high integrity ground connection.

B. Performance Requirements

1. Environmental Conditions: -4ºF to 140ºF
2. Mounting: 35 mm DIN rail.
3. Connections

    a. Intrinsic safety side: blue plug-in screw terminal blocks.
    b. Safe area side: green plug-on screw terminal blocks.
    c. Wire size: 14 AWG to 24 AWG.

4. Housing Material: Polyamide PA non-reinforced.
5. Location of Unit: Rated for Class 1 Div 2 (Groups A, B, C, D)
6. Indicators: LED indicators for power, signal status and line fault detection.

C. Subject to compliance with requirements, provide products by one of the following manufacturers

1. Turck
2. Phoenix Contact
3. Engineer approved equal

2.4 SURGE PROTECTION

A. General

1. Surge protection shall be provided for all Primary Process Measurement Devices.
2. Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate junction box (compatible with the area designation) coupled to the enclosure.

B. Field-mounted Process Transmitters

1. Phoenix Contact
2. Surge Suppression, Inc.
3. Eaton Crouse-Hinds TP48 Series
4. Or approved equal

2.5 SPARE PARTS AND TEST EQUIPMENT

A. Furnish and deliver the spare parts and test equipment as outlined below, identical to and interchangeable with similar parts furnished under this Section.

B. Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. The following shall constitute the minimum spare parts

1. Five of each type input-output relay for each 40 or less furnished for this Contract.
2. One replacement power supply for each type and size furnished for this Contract.
3. A one-year supply of all expendable materials.
4. One per five of gauges, indicators and/or switches used in field complete with diaphragm seals, filled and ready for use.
5. Provide one per ten, or part thereof, per range of field instruments including all insertion type instruments. No spares are required for in-line instruments such as magnetic flow meters and venturis that include flow tubes through which the flow passes.
6. One dozen of each type and size of fuse used in instruments.

D. The following shall constitute the minimum test and calibration equipment.

1. All tooling required to insert, extract and connect any internal or external connector, including edge connectors.
2. All special calibration equipment required for system calibration.
3. A calibrator for magnetic flow transmitters.

E. All spare parts shall have been operated and tested in the factory as part of factory testing prior to shipment of the control system.

F. For process sensors and all other analog instruments, the supplier shall submit a separate quotation for a recommended list of spare parts and test equipment. Each item recommended shall be listed and priced separately. The spare parts quotation shall contain a statement that the prices quoted are firm for a period of one year from the installation date of the equipment, and that the supplier understand that the Owner reserves the right to purchase none, any, or all of the parts quoted. The supplier is required to show that a stock of spare parts and test-equipment is obtainable within a 48-hour period.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Transmitters and instruments, which require access for periodic calibration or maintenance, shall be mounted so they are accessible while standing on the floor. Care shall be taken in the installation to ensure sufficient space is provided between instruments and other equipment or piping to allow for easy removal and servicing.

B. All items shall be mounted and anchored using stainless steel hardware, unless otherwise noted.

C. All field instruments shall be rigidly secured to walls, stands or brackets as required by the manufacturer and as shown.

D. Conform to all applicable provisions of the NEMA standards, NEC and local, State and Federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, TESTING, AND TRAINING

A. Comply with the requirements of Section 40 90 00 “Instrumentation and Control for Process Systems”.

END OF SECTION 40 91 00

SECTION 40 91 13.29 – PH LEVEL PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems
2. Section 40 91 00 – Primary Process Measurement Devices
3. Section 40 94 50 – Process Control Descriptions

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all pH Level Process Measurement Devices shown and specified herein.
2. Contract Documents illustrate and specify functional and general construction requirements of the pH Level Process Measurement Devices and do not necessarily show or specify all components, wiring, electrical conduit, piping and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, electrical conduit, accessories and labor required for a complete, workable, and integrated system.
3. Contractor shall be responsible for providing taps in the process piping systems for installation of pH Level Process Measurement Devices.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

1.3 DEFINITIONS (NOT USED)

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.7 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 90 00 – Instrumentation and Control for Process Systems and Section 40 91 00 – Primary Process Measurement Devices

1.8 FIELD CONDITIONS

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Rosemount
2. Hach / Great Lakes
3. Endress-Hauser

2.2 pH SENSOR AND TRANSMITTER

A. Type: Continuous monitoring system consisting of pH sensor and a microprocessor-based analyzer/transmitter designed to measure pH of the sample and produce a proportional output signal linear to the pH.

B. Performance

1. Sensor

a. Range: 0 to 14 pH/(-)500 to (+)500 or 0 to 1000 millivolts.
b. Response Time: 95 percent of full scale in five seconds.

2. Analyzer/Transmitter

a. Range: Same as sensor.
b. Sensitivity: 0.05 percent of span.
c. Repeatability: 0.05 percent of span.
d. Stability: 0.05 percent of span for 24 hours, non-cumulative.
e. Outputs: 4 to 20 mADC direct acting and isolated into 0 to 1000 ohms at 24 VDC power supply.
f. Ambient Temperature Range (Transmitter): -22ºF to 122ºF.
g. Ambient Relative Humidity: 0 to 90 percent RH non-condensing.

C. Construction Features

1. Sensor

a. Body: Polyvinylidene DiFluoride (PVDF) or PEEK.
b. Electrodes: pH and reference electrodes to be contained in sensor body.
c. Sensor to contain thermistor for process temperature correction.
d. Sensor to be constructed to allow replenishing of pH 7 buffer in the standard electrode chamber.
e. Provide submersible, flow-through or convertible mounting type sensor, as required.
f. Cable: PVC jacketed submersible type cable terminated in numbered spade lugs. Provide length as required to connect to remotely mounted transmitter (25 feet minimum length).
g. Connection: 3/4-inch NPT female.

2. Analyzer/Transmitter

a. Microprocessor-based solid-state circuitry designed for measurement of pH and transmission of proportional output signal linear to pH.
b. Built-in simulator used in conjunction with front panel controls and display to simulate input parameters and to verify calibration, proper internal functioning of the analog-to-digital conversion, processing, outputs, and setting up alarms.
c. Front of panel membrane sealed keypad switches for display control and transmitter function control testing and calibration. Unit design and switches shall allow output expansion to 1 pH full-scale span for any part of the range between 0 and 14. Front panel switch shall also allow alternate display of readouts for pH, temperature mV and mA outputs.
d. Built-in Self-Diagnostics: Error messages shall be presented on the display to indicate operational and equipment malfunctions. Operational errors shall include questionable calculation results, insufficient data, excessive input noise, input measurement, or calculated results out of range. Equipment problems shall include read-only memory fails check sum, random-access memory problem, identification error, card in wrong position, switch failure, wrong or no input card.

e. Indicator: 4-1/2 digit LCD indicator with measurement unit and configuration constant identifiers; 7/8-inch high digits.
f. Alarm Outputs: none.
g. Housing: Thermoplastic, weatherproof, NEMA 4X enclosure with transparent vision panel for viewing the indicator and controls and equipped with brackets to allow for handrail, surface mounting or pipe stand mounting.
h. Power Supply: 120 VAC, 60 Hz, 15 watts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

END OF SECTION 40 91 13.29

SECTION 40 91 13.36 – TOTAL ORGANIC CARBON ANALYZERS

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. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems
2. Section 40 91 00 – Primary Process Measurement Devices
3. Section 40 94 50 – Process Control Descriptions

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all Total Organic Carbon Analyzers shown and specified herein.
2. Contractor shall provide all components, piping, wiring, electrical conduit, accessories and labor required for a complete, workable, and integrated system.
3. Contractor shall be responsible for providing taps in the process piping systems for installation of Total Organic Carbon Analyzers.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

1.3 DEFINITIONS

A. Abbreviations

1. TOC – total organic carbon
2. TC – total carbon

B. Terms (Not Used)

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”.

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”.

1.7 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 90 00 “Instrumentation and Control for Process Systems” and Section 40 91 00 “Primary Process Measurement Devices”.

1.8 FIELD CONDITIONS

A. Comply with the requirements of Section 40 91 00 “Primary Process Measurement Devices”.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

B. Any instruments that are not stored in strict conformance with the manufacturer’s recommendation shall be replaced.

1.10 MAINTENANCE

A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

B. It is acceptable to require routine maintenance on a regular basis to keep the system operating efficiently.

1. 7-Day (Weekly) Maintenance.
    a. Visual inspection of gas and liquid flow.
    b. Check sample conditioning system.

2. 30-Day (Monthly) Maintenance.
    a. Replenish TIC removal reagent and calibration standards.
    b. Check feed rate of pumps.
    c. Inspect combustion furnace and salt trap.
    d. Perform automatic clean and verify operation.
    e. Perform automatic calibrate (adjustment) and verify operation.

3. 90-Day (Quarterly) Maintenance.
    a. Clean strip and separation chamber.
    b. Replace glass beads in DIN filter.
    c. Calibrate pH sensor.
    d. Replace pump hoses.
    e. For salt content 1g/ or higher, replace acid filter, replace catalyst and clean combustion chamber.

C. It shall be acceptable to make routine adjustments according to the application's specific needs.

PART 2 - PRODUCTS

2.1 TOTAL ORGANIC CARBON ANALYZER

A. Provide LAR Process Analysers QuickTOC Ultra.

1. No equals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 40 91 00 "Primary Process Measurement Devices".

B. Contractor will install the analyzer in strict accordance with the manufacturer's instructions and recommendation.

C. The standard one-year warranty against manufacturing defects shall be extendable to three-years on covered equipment if paid start-up service is accomplished on that covered equipment by an authorized service provider.

1. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances for proper installation of instruments.
2. General contractor
3. Electrical or Instrumentation contractor
4. Factory trained authorized service provider or representative
5. Site (owner/operator) personnel
6. Engineer

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. The Resident Engineer shall witness all instrument verifications in the field.

C. The factory-authorized service representative shall verify installation of all installed sensors, cables and transmitters.

D. The factory-authorized service representative shall notify the Owner and Engineer in writing of any problems or discrepancies and proposed solutions.

E. Prepare test and inspection reports, including a certified report that identifies the TOC Analyzer and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.3 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.

3.4 STARTUP SERVICE

A. Perform startup services

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, program/reprogram, and maintain TOC Analyzers.

END OF SECTION 40 91 13.36

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SECTION 40 91 19.29 – LIQUID PRESSURE PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems
2. Section 40 91 00 – Primary Process Measurement Devices

1.2 SUMMARY

A. Scope:

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all Liquid Pressure Process Measurement Devices shown and specified herein.
2. Contract Documents illustrate and specify functional and general construction requirements of the Liquid Pressure Process Measurement Devices and do not necessarily show or specify all components, wiring, electrical conduit, piping and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, electrical conduit, accessories and labor required for a complete, workable, and integrated system.
3. Contractor shall be responsible for providing taps in the process piping systems for installation of Liquid Pressure Process Measurement Devices.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

1.3 DEFINITIONS (NOT USED)

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.7 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 90 00 – Instrumentation and Control for Process Systems and Section 40 91 00 – Primary Process Measurement Devices

1.8 FIELD CONDITIONS

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Ashcroft
2. Foxboro
3. Rosemount, Incorporated
4. US Gauge
5. United Electric Controls

2.2 PRESSURE TRANSMITTER (DIFFERENTIAL AND GAUGE)

A. Type: Two-wire, differential capacitance or resonant type transmitter.

B. Required Features and Accessories:

1. Accuracy (includes combined effects of linearity, hysteresis and repeatability): ±0.10 percent of calibrated span.
2. Repeatability: 0.05 percent of calibrated span.
3. Hysteresis: 0.05 percent of calibrated span.
4. Stability (drift over a six month period): Not more than ±0.25 percent of transmitter's upper range limit.
5. Ambient Temperature Effect: Total Error per 100ºF change between the limits of -20ºF and +180ºF: Not more than ±1.0 percent of the transmitter's upper range limit (maximum span).
6. Supply Voltage Effect: Output change not greater than 0.005 percent of span for each one-volt change in supply voltage.

7. Output:

    a. Isolated direct acting 4 to 20 mADC.
    b. Digital process variable signal superimposed on 4 to 20 mADC signal without compromising loop integrity.

8. Solid state electronic components.
9. Positive overrange protection of at least 1.25 times the maximum span limit.
10. Calibration Adjustments:

    a. Zero: Adjustable in electronics compartment.
    b. Span: Course and fine span adjustments in electronics compartment.

11. Zero elevation and suppression capability to the extent that the amount of suppression plus calibrated span does not exceed the upper range limits of the sensor.
12. Adjustable internal damping.
13. Measuring elements protected by sealing diaphragm.
14. Built-in electrical surge and RFI protection.
15. Valves:

    a. For gauge pressure measurement: in all cases, except for interlock safety, provide a single shutoff valve at the process line tap to enable live process removal of the transmitter. Comply with requirements of Article 2.1, above.
    b. For differential pressure measurement: provide a three-way valve manifold constructed of 316 stainless steel on the differential pressure transmitter for pressure equalization and shutoff. Comply with requirements of Article 2.1, above.

16. Integral square root extraction providing linear 4 to 20 mADC output proportional to flow when required.
17. Electric Conduit Connection: 1/2-inch NPT.
18. Process Connections: 1/2-inch NPT.
19. The transmitter shall be loop powered from an external DC voltage source (24 VDC nominal).
20. Type 316 stainless steel mounting bracket and hardware suitable for mounting transmitter on flat vertical surface or 2-inch diameter pipe.
21. Process Wetted Parts: Type 316 stainless steel.
22. Non-Wetted Parts:

    a. Body and Process Connection Bolting: Type 316 stainless steel.
    b. Housing and Cover: Die cast low copper aluminum alloy finished with epoxy paint system; covers shall be threaded and seated on Buna-N O-rings; NEMA 4 rating.
    c. Capsule Fill Liquid: Silicone oil.

23. Indicator: Provide integral indicator in engineering units.
24. Hazardous Area Requirements: Where so required, provide transmitters rated for use in Class I, Group D, Division 1 hazardous areas.
25. Hand held interface with keyboard and LED display capable of easily configuring and testing the transmitter.

2.3 PRESSURE GAUGE

A. Bourdon Tube Pressure Element Type, Liquid Filled Gage (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inches Hg):

1. Performance Requirements:

a. Accuracy: ±0.5 percent of span (ANSI B40.1 Grade 2A).

2. Construction Features:

a. Case:

1) Solid front design constructed of glass filled polyester
2) Color: Black.

b. Ring: Threaded, glass filled polyester.
c. Full blowout back.
d. Window: Glass.
e. Dial: White with black marking; 270-degree scale.
f. Bourdon Tube and Socket: Type 316 Stainless Steel, heliarc welded, unless otherwise specified in the Instrument Index.
g. Movement: Cam and roller movement, 300 Series stainless steel.
h. Size: 4-1/2-inch.
i. Connection: 1/4-inch male NPT back or bottom, as required.
j. Mounting: Stem, flush panel or wall mounting, as required.
k. Adjustable pointer.
l. Externally accessible zero adjustment.
m. Built-in overload and underload movement stops.
n. Pressure Snubber: Sintered Type 316 stainless steel snubber threaded into gage socket or in external stainless steel housing with 1/4-inch NPT male and female connections.
o. Filling Liquid: All applications, except Chlorine and Fluoride Systems: Flurolube Oil.
p. Process Isolation: Provide gage cocks or ball valves for process
q. Provide diaphragm seal.

2.4 DIAPHRAGM SEAL

A. General: Furnish diaphragm seals for pressure gages, pressure transmitters and pressure switches at locations shown on the Drawings and as specified.

B. Required Features:

1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
2. Instrument Connection: 1/4-inch NPT.
3. Process Connection: 1/2-inch NPT.

4. Working Pressure Rating: Equal to or greater than the attached gage or switch operating pressure specified in Section 15050, Piping Systems, whichever is greater.
5. Bolting Materials: Type 316 stainless steel.
6. 1/4-inch NPT flushing connection.
7. Filling Fluid: Silicone oil.
8. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.

C. Construction Features:

1. Top Housing: Type 316 stainless steel.
2. Diaphragms, O-rings and Gaskets:

Process Fluid	Diaphragm	O-Ring	Gasket
Sludge	Type 316 SS	Buna-N	Buna-S
Polymer	Type 316 SS	Buna-N	Buna-S
Alum	Type 316 SS	Buna-N	Buna-S
Chlorine Gas	Teflon	Teflon	Teflon
Chlorine Solution	Teflon	Teflon	Teflon
Sodium Chloride	Teflon	Teflon	Teflon
Ammonia	Type 316 SS	Teflon	Teflon
Carbon	Type 316 SS	Buna-N	Buna-N
Fluoride	Hastelloy C	Viton	Viton
Lime	Type 316 SS	Teflon	Teflon
Potassium Permanganate	Carpenter 20	Viton	Viton
Sodium Hypochlorite	Teflon	Teflon	Teflon
Sodium Hydroxide	Teflon	Teflon	Teflon
Sodium BiSulfite	Teflon	Teflon	Teflon

3. Process Side Housing Material: Type 316 stainless steel for metallic piping; CPVC to match non-metallic piping.

D. Assembly and Calibration:

1. The complete diaphragm seal assembly, including gage, switch or transmitter, shall be factory assembled, filled and calibrated to the ranges and switch set points specified prior to shipment.
2. System Supplier shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage, switch or transmitter accuracy over the specified measurement range or at switch set points.
3. Location and orientation of the gages, switches and seal assemblies shall be coordinated with the actual piping and equipment installations so that gages and indicators shall be easily read and accessed for maintenance by plant personnel.
4. Where field mounting and orientation conflicts arise due to incomplete coordination with field changes in the process piping and equipment installation, assemblies shall be relocated, re-oriented, re-assembled and re-calibrated as directed by Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

END OF SECTION 40 91 19.29

SECTION 40 91 23.33 – FLOW PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems
2. Section 40 91 00 – Primary Process Measurement Devices

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all Flow Process Measurement Devices shown and specified herein.
2. Contract Documents illustrate and specify functional and general construction requirements of the Flow Process Measurement Devices and do not necessarily show or specify all components, wiring, electrical conduit, piping and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, electrical conduit, accessories and labor required for a complete, workable, and integrated system.
3. Contractor shall be responsible for providing taps in the process piping systems for installation of Flow Process Measurement Devices.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

1.3 DEFINITIONS (NOT USED)

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.7 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 90 00 – Instrumentation and Control for Process Systems and Section 40 91 00 – Primary Process Measurement Devices

1.8 FIELD CONDITIONS

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

PART 2 - PRODUCTS

2.1 ELECTROMAGNETIC FLOW METER (FULL PROFILE MULTI POINT INSERTION MAGMETER):

A. Flow Element

1. Construction: Insertion sensor material constructed of 316 Stainless Steel and coated with NSF 61 certified epoxy coating that includes multiple electrodes strategically positioned throughout the sensor.
2. Sensor operating Temperature: +14ºF to +158ºF
3. Flow Range: 0.15 fps to 33 fps (Maximum velocities may be restricted to less than 32 fps for large diameter applications)
4. Accuracy +/- 1.0% of actual flow for 1 f/s to 32 f/s and +/- 1% from .3 fps to 1 fps
5. Provide and install 2-inch full ported valve with stainless steel nipple.

B. Indicator/Transmitter

1. Enclosure: NEMA 4X or IP65 rated
2. Display: Background illumination the button menu driven alphanumeric display to indicated flow rate, totalized values, settings, alarms and failures.
3. Power supply: 24 vdc
4. Outputs 4-20 mA (0-21 mA) into a maximum of 300 ohms

5. Signal Converter

    a. Bi-directional flow feature
    b. Eight digits counter for forward and reverse flow

6. Calibration

    a. Unit shall be factory wet calibrated with all calibration information documented and stored in the converter's non-volatile memory.

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

1. Omega Engineering OmegaMag FMG-3000
2. No approved equals

2.2 MECHANICAL SWITCH

A. The flow indicating switch shall be swinging vane, variable orifice type suitable for the applications shown.

B. Required Features

1. Enclosure: Weatherproof and explosion-proof. Listed with UL and CSA for Class 1, Groups A, B, C and D.
2. Vane shall be 301 SS, lower body: brass or 303 SS, Magnet: Ceramic, Tee: Brass, iron, forged steel or 304SS.
3. Line size and connection ends as shown.
4. Switch type: Standard of snap SPDT switch with optional DPDT snap switch.
5. Field adjustable switch setting for low flow models. Factory installed settings for remaining flow ranges.

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

1. Dwyer Instruments, Inc.
2. Omega Engineering
3. Gems Sensors and Controls
4. Or equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

END OF SECTION 40 91 23.33

SECTION 40 91 23.36 – LEVEL PROCESS MEASUREMENT DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems
2. Section 40 91 00 – Primary Process Measurement Devices

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all Level Process Measurement Devices shown and specified herein.
2. Contract Documents illustrate and specify functional and general construction requirements of the Level Process Measurement Devices and do not necessarily show or specify all components, wiring, electrical conduit, piping and accessories required to make a completely integrated system. Contractor shall provide all components, piping, wiring, electrical conduit, accessories and labor required for a complete, workable, and integrated system.
3. Contractor shall be responsible for providing taps in the process piping systems for installation of Level Process Measurement Devices.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

1.3 DEFINITIONS (NOT USED)

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.7 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 90 00 – Instrumentation and Control for Process Systems and Section 40 91 00 – Primary Process Measurement Devices

1.8 FIELD CONDITIONS

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Endress-Hauser
2. Hach
3. Rosemount
4. Siemens Milltronics
5. GE / Druck

2.2 ULTRASONIC TYPE

A. Type: Microprocessor based, non-contacting, ultrasonic type continuous liquid level measuring system consisting of a transducer, remote transmitter, and interconnecting cable which produces an output signal linear with level.

B. Performance Requirements

1. Accuracy: 0.25 percent of maximum range with temperature compensation.
2. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
3. Range: As specified in the Instrument Index.
4. Damping: Adjustable damping rate.
5. Ambient Temperature:

a. Electronics: -5ºF to 122ºF.
b. Transducer: -40ºF to 200ºF.

6. Output: Two isolated 4 to 20 mADC into 0 to 750 ohms.
7. Relay Output: Six SPDT level alarm contacts rated 5A at 250 VAC, with LED indication of relay status.
8. Power: 120 VAC, 60 Hz.
9. Filter: Electronic filter to smooth the small variations in the level signal that result from surface waves or minor disturbances.
10. Adjustable blanking distance.
11. Provide flow conversion firmware for flow applications.

C. Construction Features

1. Transmitter

a. Microprocessor based control circuitry.
b. Handheld infrared wireless keypad for system programming and configuration. Programming and configuration values shall be stored in EEPROM memory that does not require battery back-up.
c. NEMA 4X polycarbonate enclosure. Provide Type 316 stainless steel hardware for mounting at the location shown on the Electrical Drawings.
d. Display: 100 mm x 40 mm multi-field backlit LCD.
e. Units of Measure: Feet/GPM, or as specified in the Instrument Index.
f. Front panel indication of loss of echo.

2. Transducer

a. Kynar housing.
b. Integral temperature sensor for temperature compensation.
c. Piezoelectric barium titanite crystal.
d. Twelve degree beam angle for ranges less than 33 feet. Five degree beam angle for ranges greater than 33 feet.
e. Provide flange mounting or threaded pipe mounting as shown.
f. Provide coaxial communication cable from transducer to the remote transmitter; length as required.

2.3 HYDROSTATIC PRESSURE TYPE

A. Type: Measuring level by continuously measuring hydrostatic pressure via its sensing element, an ion implanted silicon semiconductor chip. Data is transmitted by an analog, 4 to 20 mADC output signal.

B. Performance Requirements

1. Accuracy: ±0.25 percent full scale.
2. Zero Offset: ±0.50 percent full scale.
3. Span: ±0.50 percent full scale.
4. Temperature Ranges: -4ºF to 122ºF.

C. Construction Features

1. Diaphragm: Type 316L stainless steel.
2. Housing: Type 316 stainless steel.
3. Cable shall be provided of required length and fully submersible construction.
4. Power supply: 12 to 28 VDC with surge and lightning protection.
5. Electrical Connection: Attached 3-wire, 20 gauge polyethylene shielded unspliced cable.
6. Panel mounted meter shall be factory calibrated for required range, shall accept 4 to 20 mADC input, shall have a 3-1/2 digit vacuum fluorescent display in feet of water, shall be NEMA 4X rated and have two relay outputs for low level alarm.

2.4 FLOAT TYPE SWITCH

A. General: The device shall be capable of detecting fluid level and initiating a signal.

B. Type: Direct acting float.

C. Required Features

1. Sealed SPDT control switch (non-mercury).
2. Actuation by steel ball.
3. High impact, corrosion resistant, polypropylene float material.
4. Heavy duty, flexible 18 gauge, three connector, neoprene-jacketed cable with waterproof connection. Provide cable length, as required.
5. Not sensitive to rotation.
6. Operating Temperature: Up to 140ºF.
7. Provide weighted stainless steel cable or mounting bracket to suit installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the requirements of Section 40 91 00 – Primary Process Measurement Devices

END OF SECTION 40 91 23.36

SECTION 40 94 33 – HUMAN-MACHINE INTERFACE

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. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems
2. Section 40 94 50 – Process Control Descriptions

1.2 SUMMARY

A. Scope of Work

1. Contractor shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install complete and operational OITs (OITs) and Human-Machine Interfaces (HMIs).
2. Work includes, but is not limited to, loading, configuring, developing, testing, documentation, and deploying in satisfactory operation all software and hardware associated with OITs and HMIs.
3. The software and hardware required for the I/O System is described in this specification and is comprised of the following types of monitoring processing and control equipment units:

    a. HMI Software
    b. OIT Hardware

B. System Licenses

1. HMI software shall be provided with all necessary software licenses to allow operation of the PMCS as specified and as supplied. Licenses shall cover all software; including, but not limited to, operating systems and networking software. Licenses shall be for an unlimited time for use on the hardware provided as part of the Contract or their successors. Licenses shall include upgrade to new versions of the software in the future. Licenses shall not be location specific within the PMCS but shall cover the use of the system by the Owner and Engineer for software development during construction.

1.3 DEFINITIONS

A. Abbreviations

1. OIT – Operator Interface Terminal
2. HMI – Human-Machine Interface
3. PLC – Programmable Logic Controller

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”.

1.7 QUALITY ASSURANCE (NOT USED)

1.8 FIELD CONDITIONS (NOT USED)

PART 2 - PRODUCTS

2.1 HUMAN-MACHINE INTERFACE (HMI)

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

1. Rockwell Automation FactoryTalk View Machine Edition by Allen-Bradley
2. Wonderware InTouch Machine Edition by Schneider Electric
3. Or equal

B. HMI System Software

1. HMI software shall monitor network resources and maintain current and historical performance information and statistics on all networked devices such as Servers, Workstations, PLC’s, Remote I/O, Distributed I/O, Variable Frequency Controllers, Power Monitoring hardware, Networking hardware, etc. Management displays shall identify

system faults, permit escalation of station faults and attached devices, fail and restart stations and attach/detach devices.

2. HMI system level software shall include real time calendar/time, file management and dynamic memory allocation, on-line, on-demand and automatic diagnostics, communication and system level access security and automatic startup, fail over and shutdown routines.
3. Specifics for the system are provided as a guide; however, manufacturer's standard packages that can accomplish all of the specified functions will be considered.
4. All HMI system software shall be supplied on compact discs (CDs) or digital video discs (DVDs) and shall provide fast system start-up, simple installation, and ease of building tasks, control schemes, and displays. For added security, the system furnished shall include provisions for copying the contents of main memory to recordable backup media through the use of single system commands. The recordable backup media shall then serve as a backup for reloading the system if required. System software shall provide for convenient addition, modification and control and alarm strategies, or trend and report formats.

C. HMI Communication Software

1. Data communication subsystems shall be comprised of industrial grade redundant communication buses that provide high-speed data transmission between all networked devices such as Servers, Workstations, PLC's, Variable Frequency Controllers, Power Monitoring hardware, Networking hardware, etc. Each communication network shall be designed around the International Standards Organization's Open System Interconnection (OSI) Model, IEEE 802 Industry Standards and support a hierarchical communications network. Full TCP/IP and UDP support shall be provided.
2. Full peer-to-peer communication between nodes shall be provided. Local area network access shall be allowed via any appropriate third party network interface connector.
3. Communications hardware shall be as specified in Section 409413 Digital Process Control Computers.

D. HMI System Configuration Tools

1. A fully integrated HMI programming software package shall be provided to create and maintain process graphic screens, report generators, and system-wide configurations. The software shall be designed to execute independently so multiple copies of each tool can be deployed simultaneously on separate hardware platforms.
2. The HMI configuration software shall use an intuitive, menu-driven environment and base package platform. These easy-to-use Graphical User Interface (GUI) packages shall perform configuration and maintenance operations. Each viewing node in an on-line system shall contain an up-to-date view of all data needed by that node to monitor and control system processes.
3. Security shall be an integral component of the configuration software package. The HMI software shall provide two levels of access: viewing of system data and editing of the system. The system shall include, but not be limited to, process screens, data tables, scripts, etc.
4. The HMI configuration software shall allow easy integration of third-party products by being OLE Process Control (OPC) compliant.
5. The HMI configuration software package shall consist of the following:

a. A database builder capable of developing a local database used to hold process data and objects.
b. An Object Builder utilizing user-friendly intuitive package.
c. A Graphics Builder for rapid creation and editing of high-resolution process graphics.
d. A Script Compiler used to create custom user defined process actions or utilities.
e. An export utility allowing for import or export of data to other systems.

6. The HMI configuration software shall allow viewing the complete database record of the selected process objects as well as making adjustments to point attributes such as scan status, alarm limits, and value.
7. The HMI configuration software shall allow reviewing and adjusting object related information, such as points generated from a list with specific characteristics, status conditions, and qualities. Review types shall include; Value limits, Engineering range limits, Limit alarms, Value clamp limits, Sensor limits, Alarm check remove, Cutout from alarming, Value clamp off, Entered value, External calibration, Scan remove, Tagged out, Timed out, and Quality.
8. The HMI configuration software shall provide capabilities to define and maintain the data associated with all system device configurations, including controller parameters. The HMI configuration software shall not depend on availability of Project hardware, allowing the entire configuration to be defined before the final system is assembled.
9. The Graphics Builder shall enable users to create and edit full-color, high resolution system displays. It shall use standard “click and drag” features for drawing, moving, and sizing objects and access drawing attributes (such as color, line width, fill pattern and text size) from scrolling menus. Users shall be able to build interactive objects such as buttons, check boxes, choice items, event menus, and sliders. An extensive symbol editor shall provide the capabilities to create, define, and store a minimum of 256 custom shapes.
10. The Object Builder shall also include support for conditional code (IF and LOOP commands), definition and inclusion of mathematical calculations, and reuse of existing objects.
11. The Object Builder shall enable users to add, delete, or modify process objects. To prevent name duplication, the Object Builder shall perform an immediate HMI database consistency check of added points. It shall also check whether attribute values for field objects are the correct type and range as the user enters all required fields.
12. With the Object Builder, users shall be able to define I/O parameters associated with each process object and perform complex queries of the database regarding any data point. I/O parameters shall include I/O type, memory address, description, calibration information, and conversion coefficients.
13. The HMI architecture shall support on-line execution (changes are reflected immediately on the running system) or off-line (work in progress). Support of on-line and remote upgrades of the components shall include on-line changes to the licensing manager.
14. The Database Builder shall provide the basic mechanisms for inserting data, organizing data in a meaningful way, securing data from unauthorized access, and retrieving data.
15. Changes to the distributed databases shall be performed as objects are added or updated in the Master Database. Online edits shall not remove the HMI system from service.

E. Reporting Software

1. Reporting Software shall provide the framework for defining and generating system reports including:

    a. Temporal Reports that are executed and scheduled in real time or periodic intervals.
    b. Event Reports to summarize activity of user-defined data, which occurs during an event, triggered by one or more conditions.
    c. Trip Reports to provide information prior to and following an equipment malfunction.
    d. Operator Requested Reports to provide information based on an operator's request.
    e. Calculated Reports to provide month-to-date information for processing data.

2. Report Builder

    a. A Report Builder shall be provided on each Historical Server and on each Development Workstation to define the format of reports. Free formatting shall be provided using commercially available reporting software for flexibility when defining the layout of a report. Presentation of the reports shall be enhanced by the ability to choose several chart formats and by adding color to highlight information. Report templates and macros shall be available for frequently used formats.
    b. The Report Builder shall allow the user to quickly review or recall a cell's definition and format. The Report Builder shall be able to replicate reporting styles for multiple processes that are identical. This shall enable the user to make changes to reporting style in one place.

3. Report Generator

    a. A Report Generator shall construct a report using a layout defined by the Report Builder and the appropriate system data. Report definitions shall include the report layout, data, and report trigger (request, event, or timer). Data shall be retrieved from the data logger as necessary. Report generation shall be able to be triggered by an operator request, an event, or a user-defined periodic timer. After report generation, output shall be sent to a report printer or saved as a file in either ASCII or commercial spreadsheet format.

4. Data Logging Software

    a. Data logging software shall be provided on each Historical Server. The data logging software shall provide mass storage and retrieval of process data and alarms to be retrieved by the reporting software. Integrated tools shall provide viewing, sorting and data analysis without the need for additional software.
    b. Scanning and Collecting: The data logger shall scan and collect the following types of historical data defined by user:

        1) Real-Time Process Value History: The data logger shall monitor and store process point data at user defined intervals. Collection shall be for points defined by the user. The data logger shall also process individual user requests to retrieve process point information, providing data for operator trending

functions. The software shall include the option to export all stored data to a flat file format, text delimited, web page, and a standard spread sheet.

2) Aggregated Value History: The data logger shall collect, calculate and store aggregated value data at user defined intervals. Collection shall be for points defined by the user. Aggregated values shall include, but not be limited to; averages, maximums and minimums for all analog instrumentation; daily and lifetime totalizers for all flow instruments; and lifetime run time hours for all motorized equipment. The software shall include the option to export all stored data to a flat file format, text delimited, web page, and a standard spread sheet.

3) Alarm History: The alarm historian shall receive and store all alarms. Once the alarms have been stored, the historian shall allow an Operator to display, print, or save to a file the list of alarms collected. It shall also provide the capability to filter the alarm list based on factors such as point name or time period. The software shall include the option to export all stored data to a flat file format, text delimited, web page, and a standard spread sheet.

F. Historical Trend Data Logging Software

1. Historical trend data logging software shall be provided on each Historical Server. The historical logging software shall provide mass storage and retrieval of process data to be retrieved by the HMI software's historical trending package. Integrated tools shall provide viewing, sorting and data analysis without the need for additional software.
2. The historical trend data logger shall scan and collect real-time process value history at user defined intervals. Collection shall be for points defined by the user. The historical logger shall also process individual user requests to retrieve process point information, providing data for operator trending functions.
3. The software shall include the option to export all stored data to a flat file format, text delimited, web page, and a standard spread sheet.
4. Historical trend data logs shall be stored in individual daily files containing data from one 24-hour period.
5. Historical trend data logs shall be stored for a minimum of 180 days.
6. Historical trend data logs shall be stored in a manner that they may be manually backed up to recordable media periodically and easily restored from backups. This backup and restore process shall not remove trend collection from service.

2.2 OPERATOR INTERFACE TERMINALS (OIT)

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

1. PanelView Plus by Allen Bradley
2. Wonderware InTouch Panel PC by Schneider Electric
3. Advantech TPC Series Automation Panels
4. Schneider Electric Magelis XBT-GT

B. General Requirements

1. All stations shall be functionally similar as to display arrangements, menu selections, command terminology, and data access methods.
2. OIT's shall be functionally interchangeable differing only in the software installed on each type. OIT's shall be capable of accessing typical operator process control functions. Each station's functional environment shall be password protected for system security and user identification.
3. Provide all necessary interface hardware and protocol drivers for the supplied systems.
4. All of the OITs shall comply with the following general requirements as a minimum.

    a. Certifications: The Operator Interface Terminal will have certifications by CE, CSA, UL Class 1 Division 2 T4A or T5 (UL and CSA), and C-Tick
    b. Power Supply: The Operator Interface terminal will have a nominal voltage of 24VDC with a range of 19.2-28.8Volts DC. The power supply will have a voltage cut of </= 10milliseconds maximum and an Inrush current of </= 50A Maximum. Connection of power will be via a 3 terminal screw terminal block. This block will be pitched at least 5mm, and will have a tightening torque of 0.5Nm.
    c. Real-time Clock: All OITs shall have a built-in real-time clock.

C. Environmental Requirements

1. OIT's shall be capable of withstanding the following criteria as a minimum.

    a. Temperature: Operating: 0º-50ºC (32º-122ºF). Storage: -20º - 60ºC (-4º - 140ºF)
    b. Relative Humidity: non-condensation humidity of 0-85%.
    c. Altitude: 0-6500 feet above sea level minimum without derating.
    d. Degree of Protection: Front panel rating of IP 65 and conform to IEC 60529. This rating shall be a NEMA 4X rating suitable for indoor use only. The back panel rating shall be IP 20 and conform to IEC60529.
    e. Vibration: The operator Interface Terminal shall conform to one of the following

        1) IEC 60068-2-6. The Terminal shall be capable of 5-9Hz at 3.5 mm, and 9-150Hz at 1g.
        2) IEC 61131-3; 1gn 5Hz to 150Hz (maximum 3.5 mm (0.13 in.))

    f. Electrostatic Discharge: The OIT Terminal shall conform to one of the following

        1) IEC61000-4-2, level 3.
        2) 6 kV direct contact, or 8Kv air contact

    g. Electromagnetic Interference: The OIT Terminal shall conform to one of the following

        1) IEC 61000-4-3, 10 V/m.
        2) 10 V/m / 80 MHz to 2.7GHz Sinus amplitude modulated 80 % 1 kHz + Internal clock frequency

D. LARGE OPERATOR INTERFACE TERMINAL

1. Description: Large OITs shall have viewable screen sizes between eleven (11) inches and sixteen (16) inches.
2. Screen Type: Large OITs will use a color TFT screen with 65,536 solid colors, or 16,384 colors if flashing. The screen shall have an 800x600 pixel (SVGA) resolution, with a backlighting service life of 50,000 hours of continual usage. There shall be an embedded analog touch sensitive zone with a resolution of 1024x768. The screen shall have eight (8) levels of brightness via tactile feedback.
3. Primary Memory: 32Mb flash EPROM memory and a Compact Flash expansion memory slot. The Compact Flash slot shall be capable of handling cards up to 1GB.
4. RAM: Lithium batteries to back up 512Kb SRAM.
5. OIT's shall have video and audio input jacks for connection to a video camera. The OIT shall also have audio output jacks.
6. Communication Ports: RJ-45 port, and an integral 9-way male SUB-D connector, dedicated to serial communications. The 9-way SUB-D connector shall support RS232/RS485 Communications. The RJ-45 port shall support RS485 communications and be compatible with Siemens MPI. Additionally, two (2) type A host USB connectors shall be provided for application downloading and peripheral use. Furthermore, the terminal will be supplied with an integral RJ-45 port dedicated to 10BASE-T/100BASE-TX Ethernet TCP/IP communications. OITs relying on the same port for communications and downloading shall not be acceptable.
7. Communication Protocols. Modbus TCP/IP, EtherNet IP, and Siemens Ethernet.

PART 3 - EXECUTION

3.1 HMI/Reporting

A. HMI code shall be supplied to the Owner with fully descriptive screen and tag data.

B. HMI's shall be based upon the existing installation and shall be field verified. The Contractor shall be responsible for providing all necessary licenses, drivers, and required network and software packages as required, for the configuration as detailed in the project plans. The Integrator shall be required to provide the necessary HMI screens to monitor and control the equipment installed in this project. The Contractor shall be required to submit the proposed HMI screens to the Engineer and Owner for approval a minimum of eight weeks prior to the factory testing.

C. All available functions represented on the screens shall be easily identified. The Operator shall not be required to navigate multiple levels of menus to perform a control function.

D. All alarms generated by equipment installed on the project shall be displayed in the alarm summary page. The Integrator shall coordinate with the Owner when configuring the system alarms and subsequent actions. The use of HMI alarm tags will not be allowed unless sufficient reason is submitted and approved.

3.2 INSTALLATION

A. Install all equipment and components in accordance as shown, with approved Shop Drawings and installation instructions furnished by the manufacturer.

B. Mounting: Flush with enclosure door per manufacturer's instructions.

C. Anchor OIT's within enclosures as recommended by the manufacturer.

D. Provide spacing around OIT's as required by the manufacturer to insure adequate cooling. Insure that the air surrounding and penetrating the rear and sides of the OIT has been ambiently conditioned to maintain the required temperature and humidity range of the Operator Interface Terminal.

E. Wires entering and exiting OIT's shall be sized to comply with manufacturer's requirements.

F. During installation, upper ventilation slots shall be covered to prevent accidental debris entry. However, during normal operation ventilation slots shall not be blocked, or obstructed by any means.

3.3 IDENTIFICATION

A. Comply with the requirements specified in Section 260553 Identification of Electrical Systems.

END OF SECTION 40 94 33

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SECTION 40 94 43 – PROGRAMMABLE LOGIC PROCESS 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.

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control for Process Systems
2. Section 40 95 13 – Process Control Panels and Hardware

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment, software and incidentals as shown, specified and required to furnish and install a fully functional Programmable Logic Process Controller (PLC) system.
2. PLC or components no longer under full support or being removed from full support by the PLC manufacturer within two years of scheduled installation shall not be acceptable.
3. All materials and equipment furnished under this Contract shall be new, free from defects, of first quality, and produced by a manufacturer regularly engaged in the manufacture of these products.
4. The PLC configuration indicated is diagrammatic. The PLC system shall include as a minimum power supply, network connections, I/O cards, CPU and power supply as shown on the Contract Drawings to achieve the specified functionality.
5. The final system configuration shall utilize the PLC manufacturer's standard hardware and software to meet the functional requirements of these Specifications.
6. All equipment furnished under this Contract shall be provided to meet the functional requirements of these Specifications plus a 20 percent growth in project requirements. All equipment shall be provided under this Contract, such that the entire 20 percent project growth can be implemented into the PLC, without any additional hardware cost to the Owner.
7. The PLC system shall be capable of being integrated into a larger plant wide PLC communications network.

8. The hardware required for the PLC is shown on the Drawings and includes, but is not limited to, the following types of major monitoring processing and control equipment units:
    a. Redundant Fiber Optic Communication System
    b. Fault tolerant programmable logical controller(s) with local and remote I/O subsystem
    c. Peripheral Printers and Projection System
    d. Network communication devices, including all required cables and connectors
    e. Power Supplies
    f. Telemetry Units
    g. I/O Cards
    h. I/O Chassis and Cabling

1.3 DEFINITIONS

A. Terms

1. Human Machine Interface (HMI): Operator Interface to control system. Allows operator intervention and monitoring of all systems and subsystems connected to the PLC system; usually a desktop computer or industrial hardened computer.
2. Programmable Logic Process Controller (PLC): The controlling device used to control and monitor hardware connected to it by way of networks and/or I/O cards.
3. Backplane: Usually will indicate the I/O chassis that the power supply, PLC and I/O cards, and network cards reside in.
4. I/O Cards: Can be either analog or discrete cards that interface between field devices and PLC.
5. Server: Computer having one or more CPU's used for a specific task such as data depository, web management.
6. Peripheral Devices: Includes, but not limited to, printer(s), display devices and standalone intelligent devices, such as remote HMI stations.
7. PLC System: Includes all parts listed above.

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 – Instrumentation and Control for Process Systems.

1.7 QUALITY ASSURANCE

A. System Supplier

1. Contractor shall engage the services of a System Supplier to provide all equipment listed in this Section. The System Supplier shall demonstrate a minimum five years of experience providing PLC systems and be able to show evidence of at least five installations of equal or greater size to the one being specified.

1.8 FIELD CONDITIONS (NOT USED)

1.9 WARRANTY

A. Provide two-year extended warranty from the date of Substantial Completion.

1.10 MAINTENANCE

A. The PLC vendor shall provide recommended preventive maintenance tasks, schedules and instructions for hardware supplied. The PM documentation must be clear, applicable to hardware provided, concise and accurate.

B. Spare Parts. The following spare parts shall be provided, as a minimum:

1. I/O Modules: Determine the number of spare modules of each type required using the formula: (number of modules required by Drawings) divided by 20, then rounded up to next whole number
2. One of each type PLC processor
3. One of each type communications module
4. Two of each type PLC power supply module
5. Fuses: Determine the number of fuses of each type required using the formula: (Number of fuses provided with PLC System) divided by 10, then rounded up to next whole number

PART 2 - PRODUCTS

2.1 MEDIUM PROGRAMMABLE LOGIC CONTROLLER

A. Processor

1. Memory: 2MB
2. User replaceable battery

B. Communications

1. 1 Ethernet/RJ-45 port
2. 1 RS232 serial port

C. I/O Modules (provide as required)

1. Analog inputs:
   a. Voltage: 24V DC
   b. Current Range: 4 to 20mA DC
   c. 8 inputs, differential (min.)
2. Analog outputs:
   a. Voltage: 24V DC
   b. Range: 4 to 20mA DC
   c. 8 outputs, single-ended (min.)
3. Discrete inputs
   a. Voltage:
      1) 120V AC (non-hazardous)
      2) 24V DC (intrinsically-safe circuits)
   b. 16 inputs
4. Discrete outputs
   a. Voltage: 120V AC
   b. 8 outputs, individually isolated

D. Subject to compliance with requirements, provide products by one of the following manufacturers

1. Allen-Bradley CompactLogix 5370 L3 Controller, Model 1769-L33ER
2. Siemens Simatic S7-300
3. Schneider Modicon M340 PAC

2.2 SOFTWARE

A. Software provided for the PLC system shall be Microsoft Windows 7 operating system based.

B. The PLC software provided shall be compatible with the PLC hardware provided. The software required for the PLC is comprised of the following types of components:

1. Latest version of fully licensed PLC programming and configuration software, RsLogix5000 or equal
2. Latest version of fully licensed communications software and drivers for supplied PLC to PC communication, RSLinx Professional or equal
3. Latest version of fully licensed network configuration software, RSNetWorx for ControlNet, and Ethernet/IP software with MD or equal.

PART 3 - EXECUTION

3.1 PLC PROGRAMMING

A. PLC code shall be written in either “Function Block” style or “Ladder Logic”.

B. PLC code shall be supplied to the Owner with fully descriptive comments.

C. The graphic standards to be used for all HMI equipment shall be coordinated with the Process Equipment Providers. All control panel screens will be custom.

D. The Contractor shall provide the Owner with an I/O map of all process variables in the PLC.

E. PLC code shall be the property of the Owner.

F. The Contractor shall provide three copies of all commented PLC code/script to the Owner in electronic format prior to acceptance by the Owner. Any documentation not containing symbol information or comments will not be considered acceptable.

3.2 INSTALLATION

A. Comply with the requirements in Section 40 95 13 “Process Control Panels and Hardware”.

B. PLC equipment is to be mounted on the back panel of the local control panels, unless otherwise noted, and incorporated in the panel design by the System Manufacturer.

3.3 ENVIRONMENTAL CONDITIONS

A. The complete monitoring and control system and associated input/output wiring will be used in a water/wastewater treatment facility environment where there will be high energy AC fields, DC control pulses, and varying ground potentials between the transducers or input contact locations and the system components. The system design shall be adequate to provide proper protection against interferences from all such possible situations.

B. PLC components shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:

1. Temperature range: 32 to 122ºF continuous
2. Relative humidity: 5 through 95% (non-condensing)

C. Control rooms will normally be air-conditioned to achieve environmental conditions outlined above. No positive control of relative humidity is provided or contemplated. However, in the event of a failure of the air conditioning system, the entire monitoring and control system shall be capable of operating continuously and satisfactorily with ambient temperatures between 32 and 104°F and with relative humidity to 95 percent (non-condensing).

END OF SECTION 40 94 43

SECTION 40 94 50 – 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 1 Specification Sections, apply to this Section.

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control For Process Systems
2. Section 40 91 00 – Primary Process Measurement Devices
3. Section 40 95 13 – Process Control Panels and Hardware

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to configure the SCADA System to accomplish the functionality specified herein
2. This section describes the general function and disposition of each primary process loop. The CSI shall provide additional functions as required to adhere to good control and engineering practices.
3. The process control descriptions are written descriptions of the basic configuration and/or programming required to implement the sequential control of the plant's unit processes. Finalizing and tuning of strategies, as required, by the process characteristics shall be accomplished during start-up.

1.3 DEFINITIONS

A. Terms

1. Local – monitoring and controls located at the piece of equipment.
2. Remote – monitoring and controls located away from the piece of equipment (such as an MCC) and/or programmed in SCADA.

3. RUNNING – discrete input obtained from auxiliary contacts (or data link registers) provided with the local motor control equipment (i.e., starter, VFD, RVSS, etc.) which shall close (or change value) when the equipment is running.
4. HOA IN AUTO – discrete input obtained from a dry contact which indicates that the remote HAND-OFF-AUTO (HOA) selector switch is in the "AUTO" position to permit remote control by the SCADA system.
    a. If the HOA is in "HAND", all software functions associated with that specific equipment shall not be available and PLC control of equipment shall be halted.
5. OOR IN REMOTE – discrete input obtained from a dry contact which indicates that the local ON-OFF-REMOTE selector switch is in the "Remote" position to permit remote control by the SCADA system.
6. FAULT – discrete input obtained from local motor overload and/or any other shut down mode such as seal-fail, over-temperature, low oil pressure, high vibration, etc.
7. ESTOP – discrete input obtained from local emergency stop push button.
8. SPEED IN – analog input obtained from local VFC typically shown as 0 – 100%. Speed range shall be operator adjustable under supervisory password control.
9. OPEN & CLOSED – discrete inputs obtained from limit switches indicating the position of a valve either opened or closed.
10. HOA (hand-off-auto) – remote virtual selector-switch function that allows the operator to select the mode of operation in either "HAND" (for remote manual control) or "AUTO" (for remote PLC control).
    a. If the local HOA is in the "AUTO", this function shall allow the operator to select to either control that equipment manually or allow the PLC to control automatically.
11. S/S (start/stop) – remote virtual pushbutton function that allows the operator to manually start and stop equipment. Available if the local HOA is in "AUTO" AND the remote HOA is in "HAND".
12. SPEED S/P (setpoint) – remote virtual numeric function that allows the operator to enter a numeric value from 0 – 100% that sets the speed of the associated motor. If the operator enters a value greater than 100%, the HMI or OIT shall display an error message and the motor speed shall remain unchanged. Available if the local HOA is in "AUTO" AND the remote HOA is in "HAND".
13. OPEN/CLOSE – remote virtual pushbutton that allows the operator to manually open or close a valve, gate, etc. Available if the local HOA is in "AUTO" AND the remote HOA is in "HAND".
14. SELSW – remote virtual selector switch that allows the operator to manually select one or more devices. Selector switch may have more than two selections depending on the application. Available if the local HOA is in "AUTO". Availability in remote mode will depend on application.

B. Abbreviations

1. CSI – control system integrator
2. FCP – field control panel (PSI-provided)
3. HOA – hand off auto
4. HMI – human machine interface
5. LCP – local control panel (CSI-provided)
6. MCC – motor control center
7. OIT – operator interface terminal
8. PMCS – plant monitoring and control system
9. PSI – process system integrator
10. PSI – process systems integrator
11. RVSS – reduced voltage soft start
12. SCADA – supervisory control and data acquisition
13. VFD – variable frequency drive

1.4 ACTION SUBMITTALS (NOT USED)

1.5 INFORMATIONAL SUBMITTALS (NOT USED)

1.6 CLOSEOUT SUBMITTALS (NOT USED)

1.7 QUALITY ASSURANCE (NOT USED)

1.8 FIELD CONDITIONS (NOT USED)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 DESIGN REQUIREMENTS

A. General

1. Comply with the requirements of Section 40 90 00 – Instrumentation and Control for Process Systems.

2. Automated process control at each process area and/or packaged system shall continue to operate in the event of a network failure.
3. Owner will provide Ethernet addresses to the CSI. Coordinate Ethernet addresses with PSI as applicable.

B. Monitoring and Control

1. SCADA shall be implemented such that the operator has the ability to monitor and control every device that is connected to the plant-wide communications network from the operator's human-machine interfaces (HMI's) and operator interface terminals (OIT's).
2. SCADA programming shall allow the operator to easily change the operating setpoints of all equipment that is automatically operated by the Control System. The setpoint ranges shall be hard coded such that the operator may not be allowed to enter a setpoint that allows the equipment to operate out of the range or limits set forth by the equipment manufacturer. In addition, the HMI shall have a configuration screen that allows an operator with proper security privileges to reset each of the setpoints to the default values originally programmed in the system.
3. SCADA shall automatically discover and re-configure the setting and parameters of replacement devices connected to the PMCS (e.g., VFD, solid-state overloads, RVSS, etc.)

C. Alarm Conditions

1. SCADA shall alarm the system operator whenever an alarm condition is present on any piece of equipment connected to the PMCS. The CSI shall coordinate with the Owner to determine the desired priority level for all alarms as well as call-out/paging sequencing.
2. SCADA shall alarm the system operator when any equipment that was called to run by the PLC fails to start or stops running for any reason.
3. Notify the operator of the system alarms by providing audible notification as well as displaying the alarm on the HMI with all of the associated alarm details.
4. Have the ability to be acknowledged through any of the HMI workstations or operator interfaces connected to SCADA.
5. Notify the "on call" operator in the event that the alarm is not acknowledged within a period of time to be determined by the Owner. In the event the "on-call" operator does not acknowledge or clear the fault; the SCADA system shall continue calling operators on the configured call-out list until the alarm is acknowledged or cleared.

D. Data Archival

1. SCADA shall store each operation of every piece of equipment.
2. SCADA shall store each start, stop, reset, logon, logoff, and alarm acknowledgement that an operator performs.
3. SCADA shall store the value of each analog and digital tag/variable such that the operator can trend plant data.

3.2 ELECTRICAL LOOPS

A. Generator (SD-G)

1. The control system for the Generator Switchgear Equipment is being supplied as a complete package as part of the equipment.
2. The SCADA system will interface with the Generator Switchgear Equipment to allow the operator to have full control of the Generator Switchgear Equipment & Generators under password control.
3. All HMI screens that are capable of being displayed on the HMI located on the front of the Generator Switchgear System shall be capable of being displayed on the SCADA system HMIs and OITs.
4. All alarms from the Generator Switchgear System shall be displayed on both the Generator Switchgear System HMI and SCADA system HMIs and OITs.
5. The Generator Switchgear System will use AB processors and AB PanelView operator interfaces. The manufacturer of the Generator Switchgear System will provide all of the PanelView screens to the integrator for inclusion into the Plant's SCADA system. Coordinate these requirements with the Generator Switchgear System provider.

B. Automatic Transfer Switch (SD-MB/ATS)

1. The Automatic Transfer Switch shall be provided with a fully functional control system by the manufacturer.
2. The SCADA system shall monitor the status of SD-MB/ATS.
3. The switch shall stay connected to the Normal source unless the source is unavailable for a period of time greater than 10 seconds at which time the switch may automatically switch to the Emergency source.
4. In the event that the transfer switch is forced to switch to the alternate source, it shall transfer back to the Normal source after the Normal source is available for a 10 minute period without interruption. The transfer shall be via a closed transition transfer to the Normal source.
5. The SCADA system shall continuously monitor the following information from SD-MB/ATS:

a. Normal circuit available
b. Emergency circuit available
c. Normal and Emergency statuses
    1) Open
    2) Closed
    3) Fault

3.3 INFLUENT LIFT STATION

A. The Spent Deicing Lift Station will be provided with a dedicated local PLC-based control panel provided by the Lift Station pump supplier. The control panel and VFDs for the pumps will be installed in the Mixing-Dosing Building.

B. The Lift Station control panel will be connected to the PLC/SCADA system via ethernet network.

C. In normal operation, the Lift Station shall automatically operate as programmed by the equipment manufacturer. The Level Indicating Transmitter shall be pre-calibrated for full wetwell depth and rated for Class 1 Division 1. The pumps will switch on and off based on the influent levels in the Lift Station wet well. There shall be a minimum of 6 levels of control as follows:
- Low level alarm
- Pumps off
- Lead pump on
- Lag on / pump 2 on
- High water level alarm/ pump 3 on
- High-high water level alarm

D. The full supply level in the tanks (T-1 and T-2) shall not be exceeded. Once either of the tanks are full, no further pumping from the Lift Station to a full tank will be permitted, as controlled by the tank level sensors (LIT-310, LIT-0320, LSH-0310, or LSH-0320). Once the tank is full, the PLC will close that tank, but allow for further pumping to the tank that is not full until that tank is also full. Then, the inlet valve will also be closed.

E. The Lift Station pumps will also not operate if both the tank inlet plug valves (SD-PV-101 and PV-201) are closed, the flow switches (SD-FS-01, -02, & -03 [#0141, #0142, #0143]) in Lift Station valve vault sense a no flow condition while the pump is supposed to be pumping, either of the tanks (T-1, T-2) are full (LIT-310, LIT-0320, LSH-0310, or LSH-0320), if their respective discharge plug valve (SD-PV-01, -02, and -03) is closed, or an error message is received from the pumps.

F. Before operations commence, the operator will ensure the drum screen is cleared from all debris and waste, ensure the three plug valves in the Lift Station valve vault are fully open (SD-PV-01, PV-02, PV-03) and that the tank inlet plug valves (SD-PV-101 and PV-201) to Tank 1 (T-1) and Tank 2 (T-2) are fully open or if flow is diverted into one tank only, the other tank is closed by

using the appropriate plug valve. These tank inlet valves are also actuated and can be operated remotely from inside the Mixing-Dosing building PLC or via the SCADA.

G. The pump VFD's shall not run if its respective pump disconnect is open (ZS-0101, -0102, and -0103). The VFDs will be programmed to control the level of the wet well between "Pumps off" and "Lag on / pump 2". The lower the level in the wet well the lower the motor frequency (rotational speed).

H. The sump pump (SD-SP-1) will be operated manually to drain the wet well on the completion of the deicing event and once the two tanks (T-1 and T-2) are completely drained. To enable pumping the plug valve (PV- 201) in the discharge vault of Tank 1 will be closed and the plug valve (PV-110) opened together with the valves in the Discharge Meter Box. Before the sum pump is switched on enough time will be allowed for the force main to drain close to empty once PV-110 is opened. When operating the sump pump, the discharge flow still needs to be controlled by means of manually or remotely opening the flow control valve (SD-DV-01) until the maximum permissible flow rate, metered by flow meter (SD-FM-1 [#0327]) is in accordance with the Discharge Permit limits, is achieved.

3.4 EFFLUENT METERING AND DISCHARGE FLOW CONTROL

A. Under normal operational conditions, the effluent from the two Tanks (Spent Deicing Tank 1 and Tank 2) will pass through the Spent Deicing Discharge Meter Box before entering the Diversion Box and then into the sanitary sewer for final discharge. For discharge under abnormal conditions, i.e. too low or too high pH or too high glycol concentrations, the Diversion Box is equipped with two sluice gates, the first will close discharge to the sanitary sewer and then the second will open and divert the effluent back to the lift station.

B. The control valve inside the Spent Deicing Discharge Meter Box will be set to control the flow rate out of the Spent Deicing Tanks to the sanitary sewer based on the conditions of the Discharge Permit. The flow rate could vary between 3 gpm and 250 gpm.

C. Before a discharge operation commences, the operator will do sampling and testing to determine the concentration of the Total Organic Compounds (TOC), which relate to the concentration of the Chemical Oxygen Demand (COD). Based on the COD concentration a specific flow rate will be determined in accordance with the Discharge Permit limits. This is the total combined flow permitted from one or two Tanks (SD-T-1, SD-T-2).

D. When the discharge operation commences, the Operator shall ensure that tank outlet valves (SD-PV-102 [#0314] for Tank 1) or (SD-PV-202 [#0322] for Tank 2) or both are open before discharging commences. They can either be operated manually in the field or remotely by means of the controls in the Mixing-Dosing building and the SCADA.

E. Once the Tank discharge valves are opened, the operator will ensure that the diaphragm valve (flow control valve SD-DV-01 [#0326]) is fully closed before opening the plug valve (SD-PV-303) in the Spent Deicing Meter Box. The operator can then manually or remotely open the flow

control valve (SD-DV-01) until the maximum permissible flow rate, metered by flow meter (SD-FM-1 [#0327]) is in accordance with the Discharge Permit limits is achieved. The flow will require adjustment as soon and the TOC concentration changes.

F. The flow control valve (SD-DV-01) will have a modulating actuator to adjust the flow rate as the TOC concentrations change. The flow control valve will also make the necessary adjustments (open slowly to allow a constant flow rate when tank levels are decreasing) as the tank levels change (SD-T-1, SD-T-2) to keep the flow rate in accordance with the Permit limits.

G. Sampling and testing on the effluent pH will also be done and if outside the Discharge Permit limits, it will not be permitted to be discharged to municipal sewer.

H. The SCADA System shall monitor the Total Organic Compounds (TOC) (SD-TOC-12, SD-TOC-22) and pH (SD-pH-12 [#0313], SD-pH-22 [#0321]) leaving the Spent Deicing Tanks and if the TOC does not correlate with the flow rate or the pH is outside of the limits, the sluice gate (SD-SLU-03 [#0325]) in the Diversion Box will close off and discontinue the effluent from flowing to the sanitary sewer for final discharge and an alarm will sound.

I. pH (SD-pH-12, SD-pH-22)

1. The operator shall have the ability to select setpoints for four pH alarm levels: Low, Low-Low, High, and High-High. The Low & High levels shall alarm the operator and provide time for correction prior to reaching the Low-Low or High-High.
2. If the Low-Low or High-High level is reached AND the pH is outside the limits, the SCADA system shall close sluice gate (SD-SLU-03) and open sluice gate (SD-SLU-04 [#0315]) to discontinue the effluent from flowing to the sanitary sewer until the pH is between the Low and High range.

J. TOC (SD-TOC-12, SD-TOC-22)

1. The operator shall have the ability to select setpoints for two TOC concentrations (related to a specific flow) alarm levels: High and High-High. The High level shall alarm the operator and the PLC/S to SCADA system shall close the flow control valve SD-DV-01 to align the TOC concentration with the allowable flow rate as stated in the Permit limits.
2. If the High-High level is reached, the PLC/S to SCADA system shall close flow control valve SD-DV-01 and open sluice gate (SD-SLU-04) and close sluice gate (SD-SLU-03) to reject the final effluent from discharging to the sanitary sewer. The PLC will be programmed to allow for the time delay caused by the TOC samples from the outlet of the Tanks (SD-TOC-12, SD-TOC-22) to reach the TOC analyzer (AE/AIT-0231) in the Mixing-Dosing Building and the time it takes for the sample in the TOC analyzer to be processed.

3. Upon startup of the system, be it at the beginning of the season or during periodic summer testing/exercising, close sluice gate SLU-04 and open sluice gate SLU-03 for 30 minutes minimum. This will allow TOC sampling to settle or average.

K. The plant operator shall have the ability to turn off the automatic TOC vs flow rate monitoring systems under password control and be prompted every 3 hours (or as set in the PLC) on the hour for a manual TOC and pH reading. For this purpose, an SMS text messaging service will be connected to the PLC.

3.5 REJECT/EFFLUENT BYPASS CONTROL

A. Under normal conditions, the effluent from the two Tanks (Spent Deicing Tank 1 and Tank 2) will pass through the meter and control vault before entering the Reject Control Diversion structure equipped with two sluice gates, (SD-SLU-03 & SD-SLU-04). The normal operation is for SD-SLU-03 to be closed and SD-SLU-04 to be open which allows for discharge of the effluent to the sanitary sewer and eventually to the municipal wastewater treatment plant.

B. In addition to the I/O shown on P&IDs, provide the following monitoring and/or controls:

1. Remote HOA function
2. Send a SMS to the operator/s.

3.6 SPENT DEICING TANKS

A. The Spent Deicing Storage Tanks will include level transmitters (LIT-0310 and -0320) that will report the tank level to the SCADA system. The tanks also include high level switches (LSH-0310 and -0320) as contingencies if the level transmitters fail.

1. 0 – 100% = EL. 980.45 – EL. 1013.70
2. See Section/Elevation on Sheet M-14.06.01.
3. The operator shall be able to enter four (4) setpoints to alarm and/or control the operation of the Effluent Transfer Pumps.
4. Send an SMS to the operator/s when one or/and both tanks are full.

3.7 MIXING AND DOSING FACILITY

A. Mixing pumps (SD-MP-11 and SD-MP-21) will switch on when the tank levels (T-1 and T-2) reaches 10-15% full (minimum level to be confirmed by mixing system contractor). Tank 1 is dedicated to SD-MP-11 and Tank 2 is dedicated to SD-MP-21. All valves should be open (SD-PV-103, -104, -105, -106, -107, -108, -203, -204, -205, -206, -207, -208 and SD-ARV-01, -02) except for normally closed plug valves SD-PV-301, SD-PV-302, SD-PV-109, and SD-PV-209.

B. Pump rate will be set by VFDs in accordance with tank levels as per contractor design to achieve effective mixing.

C. Operation will either be auto or manual, based on the tank level, and protected by flow switches and pressure limits.

D. Caustic dosing (see section 3.10) occurs downstream of the mixing pumps.

E. When the tank level reaches a minimum level determined by the mixing system contractor, one pump can be used to provide mixing for both tanks.

1. Plug valves SD-PV-301 and SD-PV-302 must be opened when using one pump to mix Tank 1 and Tank 2.

3.8 EFFLUENT FLOW METER

A. The SCADA System shall continuously monitor and display the following:

1. FE/FQI-0327: 0 – 100% = 2 – 250 GPM
2. Totalized flow readings for the current 24-hour period, as well as the ability for the operator to recall the totalized flow for any period over the past 24 months
3. In the trending area of the HMI, the control system shall allow the operator to Trend both instantaneous flow rates and totalized flow for a period of time of up to 24 months (operational time).
4. The operator shall have the ability to select setpoints for the flow meter alarms as stated above.

3.9 TRUCK DOCKING STATIONS

A. In case of a situation when the Spent Deicing Tanks are full, the facility intends for the tanks to be emptied by using tanker trucks. For this purpose, two Truck Docking Stations have been provided. Each station consists of a flow meter (SD-FM-2 [#0244], SD-FM-3 [#0243]), a check valve (SD-CV-12, SD-CV-22) and a V-port ball valve (SD-BV-01, SD-BV-02) for flow throttling and control.

B. Mixing pumps will also be used to deliver liquid to truck docking station 1 and 2.

1. When tanks are full, trucks can be filled during normal mixing operation by opening plug valves (SD-PV-109 for Tank 1 and SD-PV-209 for Tank 2) to allow flow to the docking station.

2. The flow rate of liquid into the trucks can be manually controlled by using the V-port ball valves near the truck docking station (SD-BV-01 for Tank 1 and SD-BV-02 for Tank 2) while monitoring the flow on the flow meter field display (SD-FM-2, SD-FM-3).

C. The SCADA System shall continuously monitor and display the following:

1. FI/FQI-0244 and -0243: 0 – 100% = 0 – 800 GPM
2. Totalized flow readings for the current 24-hour period, as well as the ability for the operator to recall the totalized flow for any period over the past 24 months
3. In the trending area of the HMI, the control system shall allow the operator to Trend both instantaneous flow rates and totalized flow for a period of up to 24 months.
4. The operator shall have the ability to select setpoints for two alarm flow rates: High and High-High. The High level shall alarm the operator and the PLC/S to SCADA system shall reduce the speed of the mixing pumps (SD-MP-11 and SD-MP-21) to align the flow with the allowable truck loading flow rate.
5. If the High-High level is reached, the PLC/S to SCADA system shall shut down the mixing pumps (SD-MP-11 and SD-MP-21) completely and sound the alarm. This may not stop the flow completely. If the flow is not stopped, the V-port ball valves (SD-BV-01 for Tank 1 and SD-BV-02 for Tank 2) must be closed completely to achieve this.

3.10 CAUSTIC SODA FEED SYSTEM

A. The discharge of effluent to the sanitary sewer system is governed by the Discharge Permit limits. The Permit specifies a pH limit and if the effluent is outside the limit no discharge will be permitted. Glycol, if exposed to oxygen for a period tends to become acidic. For this purpose, a caustic soda feed system has been provided for which consist of a 260 gal caustic soda (sodium hydroxide) holding tank (SD-T-3), two dosing pumps (SD-DP-1, SD-DP-2) and two pipe injection points (SD-NAOH-11, SD-NAOH-12) fed by the dosing pumps.

B. To continuously monitor the pH, each suction line to the mixing pumps (SD-MP-11 and SD-MP-21) is equipped with a pH probe (SD-pH-11, SD-pH-21) which is connected to the PLC/SCADA.

C. When the pH drops below the pH setpoint, the PLC will automatically start up the relevant dosing pump (SD-pH-11, SD-pH-21) and inject caustic soda into the pipe injection ports (SD-NAOH-11, SD-NAOH-12). This is followed by an inline flash mixing system.

D. The dosing flow rate will be a combination of the reading of the pH below the threshold and the level of the tanks (SD-T-1, SD-T-2)

E. The SCADA System shall continuously monitor and display the following:

1. FI/FQI,: 0 – 100% = 0 – 0.2 GPM

2. Totalized flow readings for the current 24-hour period, as well as the ability for the operator to recall the totalized flow for any period over the past 24 months
3. In the trending area of the HMI, the control system shall allow the operator to Trend both instantaneous flow rates and totalized flow for a period of up to 24 months.
4. The operator shall have the ability to select setpoints for two alarm flow rates: Low and Low-Low. The Low level shall alarm the operator and the PLC/S to SCADA system when the pH drops below 6.5 as measured at SD-pH-11 or SD-pH-21.
5. If the Low-Low pH level is reached, pH is below 6, as measured at SD-pH-11 or SD-pH-21, the PLC/S to SCADA system shall sound the alarm.
6. The level of the caustic in the caustic soda holding tank (SD-T-3) will be monitored continuously and Low alarm will be displayed when the tank level reaches 1/3 from the bottom and a Low-Low alarm when it reached 1/5 from the bottom.
7. When pH drops below 6 on any pH sensor, the outlet control valve (SD-DV-01) will shut down and an alarm will sound (a SMS will be sent to the operator/s).

F. In addition to the I/O shown on P&IDs, provide the following monitoring and/or controls:

1. Local adjustment of the dosing flow rate on the dosing pumps (SD-DP-1, SD-DP-2)
2. Pump call to RUN
3. SPEED S/P

3.11 RECLAMATION TANK DIVERSION STRUCTURES

A. The reclamation tank diversion structures (DS-1, DS-2, and DS-3) that capture the flow from the respective trench drains in the apron area will be equipped with sluice gates on the outlet pipes to the stormwater outfall or the reclamation tanks.

B. Under normal conditions, the sluice gates that regulate the flow to the reclamation tanks will be closed, only during deicing operations will the sluice gates to the reclamation tanks be opened and the gates to the stormwater outfall be closed.

C. Each gate (SD-SLU-01, SD-SLU-02, SD-SLU-03, SD-SLU-04, SD-SLU-06, SD-SLU-07, SD-SLU-08, and SD-SLU-09) will have the capability to be remotely operated from the SCADA system and will have an override switch located adjacent to the structure containing the sluice gate. The switch shall be located in the concrete box for the electrical actuator. It is recommended that the opening and the closing of the respective sluice gates will be complete in under two minutes.

D. Each gate is intended to only function in the fully open or fully closed condition.

3.12 PERISTALTIC (HOSE) PUMP

A. The peristaltic (hose) pump (SD-DP-3) will be used to pump sample spent deicing fluid from the Spent Deicing Discharge Meter Vault to the TOC analyzer within the Mixing-Dosing building. The pump will be located on top of the Spent Deicing Discharge Meter Vault with the suction inside the vault upstream of the meter.

B. The pump will be manually operated from a panel next to the TOC analyzer or from the pump itself. There will be no manual operation, but the operational status of the pump will be displayed on the PLC/SCADA.

C. Before starting the pump all the upstream valves inside the Spent Deicing Discharge Meter Vault must be in the open position including the outlet plug valve for Tank 1 (SD-PV-102) or Tank 2 (SD-PV-202) or both, and the solenoid/manual valve inside the Mixing-Dosing building next to the TOC analyzer.

D. Once the pump has been energized, the sample will take approximately thirty (30) seconds to reach the analyzer. There may however be a constant flow of spent deicing fluid once the valve next to the analyzer is open, but this may not be a recent sample from the Spent Deicing Discharge Meter Vault.

E. The peristaltic (hose) pump (SD-DP-3) is equipped with a bypass in the event of the pump being out of operation and the tanks being full enough to convey the spent deicing fluid by gravity to the TOC analyzer. In that case the pump will be locked out until the bypass is disabled.

END OF SECTION 40 94 50

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SECTION 40 95 13 – PROCESS CONTROL PANELS AND 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.

B. Related Sections

1. Section 40 90 00 – Instrumentation and Control For Process Systems
2. Section 40 95 73 – Process Control Wiring
3. Section 26 43 13 – Surge Protection for Low Voltage Electrical Power Circuits

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all process control panels and hardware.
2. Provide all electrical components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.

1.3 DEFINITIONS

A. Terms

B. Abbreviations

1. AWG – American Wire Gauge
2. BTU – British Thermal Units
3. DPDT – Double-Pole Double Throw
4. GFCI – Ground Fault Circuit Interrupter
5. LED – Light Emitting Diode
6. MTW – Machine Tool Wiring
7. NEC – National Electrical Code
8. NEMA – National Electrical Manufacturers Association
9. NFPA – National Fire Protection Association
10. PLC – Programmable Logic Controller
11. UPS – Uninterruptible Power Supply

1.4 ACTION SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”.

B. Product information

1. Manufacturer's product name and model number.
2. Instrument tag number from Contract Documents.
3. Manufacturer’s standard catalog product data.
4. Description of construction features.
5. Performance and operation data.
6. Installation and mounting details, instructions and recommendations.
7. Service requirements.
8. Dimensions.
9. Range of each device and calibration information.
10. Descriptions of materials of construction and a listing of NEMA ratings for all equipment.

1.5 INFORMATIONAL SUBMITTALS

A. Layout Drawings

1. Front, rear, and internal panel views to scale.
2. Dimensional information.
3. Tag number and functional name of components mounted in and on panel, console or cabinet.
4. Product information on all panel components.
5. Nameplate location and legend including text, letter size and colors to be used.
6. Location of anchoring connections and holes.
7. Location of external wiring and/or piping connections.
8. Mounting and installation details.
9. Proposed layouts and sizes of graphic display panels.
10. Calculations for heating and cooling.
11. Subpanel layouts and mounting details for all items located inside control panels.
12. Calculations of estimated electrical power demand and expected run time of the UPS.

B. Wiring and/or piping diagrams

1. Name of panel, console or cabinet.
2. Wiring sizes and types.
3. Piping sizes and types.
4. Terminal strip numbers.
5. Color coding.
6. Functional name and manufacturer's designation for components to which wiring and piping are connected.
7. Bill of material including tag number, functional name, manufacturer’s name, model number and quantity for all components mounted in or on the panel or enclosure.

C. Electrical control schematics

1. In accordance with NFPA 79 Standards for all circuits indicated in the Contract Documents.
2. Typical wiring diagrams shall not be acceptable.
3. Tables or charts to describe wire numbers shall not be acceptable.

1.6 CLOSEOUT SUBMITTALS

A. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”.

1.7 QUALITY ASSURANCE

A. Standards, Codes and Regulations

1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
   a. National Fire Protection Association 79, Annex “D” Standards, (NFPA)
   b. National Electrical Code, (NEC)
   c. National Electrical Manufacturer's Association Standards, (NEMA)
   d. American Society for Testing and Materials, (ASTM)
   e. Operational Safety and Health Administration Regulations, (OSHA)
   f. Underwriters’ Laboratory, Inc., (UL)
   g. State and Local code requirements
   h. Where any conflict arises between codes or standards, the more stringent requirement shall apply.

2. All material and equipment shall be new and all panels shall be built in an Underwriters’ Laboratory, Inc. (UL) approved panel shop and bear the UL label.

B. Delivery, Storage, And Handling

1. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”.

PART 2 - PRODUCTS

2.1 IDENTIFICATION

A. Provide laminated plastic nameplates for identification of panels and components mounted therein as follows:

1. Nameplates shall be of 3/32-inch thick laminated phenolic type with black matte finish surface and white letter engraving.
2. Panel identification nameplates to have 1/2-inch high letter engravings.
3. Panel mounted component (e.g., control devices, indicating lights, selector switches, etc.) identification nameplates to have 1/4-inch high letter engravings.
4. Nameplates shall be attached to the panel face with two stainless steel self-tapping screws.
5. Nameplate engravings shall include the instrument or equipment tag number and descriptive title as shown and specified.

B. Tag all internally mounted instruments and devices in accordance with the following requirements:

1. Tag numbers shall be as shown.
2. The identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self-tapping screws of appropriate size.
3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
4. Identification tag shall be installed so that the numbers are easily visible to service personnel.
5. Front of panel mounted instruments shall have the tag attached to rear of device.

C. Tagging of the following items shall be accomplished with the use of adhesive plastic Brady USA, Inc. labels, Or approved equal.

1. Tag all electrical devices (e.g., relays, timers, power supplies) mounted within control panels and enclosures.
2. Tag all pneumatic lines.
3. Numerically tag all terminal blocks.
4. Numerically tag wiring at each end.

2.2 PANELS AND ENCLOSURES

A. General

1. Panels and enclosures shall meet the NEMA requirements for the type specified.
2. Sizes shown on the Drawings are estimates. Contractor shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed within, as required.
3. Panels with 3-phase circuits shall include a mild steel dead front panel capable of protecting the operator from a bolted fault within the control panel with the outer door open. Panels purposed only for low-voltage controls (i.e., PLC and/or relay logic) are not required to have dead front panels.

B. Construction Features

1. Located inside control or electrical room areas

a. Rating: NEMA Type 12.
b. Fabricate enclosures using minimum 14-guage steel for wall or frame mounted enclosures and minimum 12-guage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
c. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
d. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
e. Provide subpanels and shelves (as required) for installation of interior devices. Subpanels and shelves shall be constructed of 12-guage steel (minimum) powered-coated white.
f. Use pan type construction for doors. Door widths shall not exceed 36".
g. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
h. Provide oil resistant gasket completely around each door or opening.
i. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
j. Use stainless steel fasteners throughout.
k. Provide steel print pocket powered-coated white.
l. Provide enclosure mounting supports as required for floor, frame, or wall mounting.
m. Provide sub-panels for installation of all relays and other internally mounted components.
n. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom, unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.
o. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.
p. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surface, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
q. All interior surfaces shall be painted with two coats of semi-gloss white polyurethane enamel.
r. All exterior surfaces shall be painted with a minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by Engineer from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color.
s. Primer and finish paint shall be compatible and shall be a low VOC, high solids polyurethane enamel, Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin-Williams, Inc. Or approved equal.
t. Provide one extra quart of touch-up paint for each exterior finish color.

2. Located outside in field
   a. Rating under cover: NEMA Type 4X/12/13.
   b. Rating exposed to rain and sunlight: NEMA Type 3R/4X/12/13. Provide drip shield as necessary to maintain the Type 3R rating.
   c. Material
      1) Corrosive environments: Type 316L stainless steel

2) Non-corrosive environments: Type 304 stainless steel
3) Construction, unless otherwise noted, with a minimum thickness of 12-guage for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.

d. 3-point latching mechanism with hasp and staple for padlocking.
e. Rolled lip around three sides of door and along top of enclosure opening.
f. Provide a clear plastic, gasketed lockable hinged door to encompass all non-NEMA 4 front of panel instruments.
g. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad.
h. Floor Pad: Refer to Part 3 of this Section.

3. Located in hazardous areas
   a. Rating: NEMA Type 7
   b. General: Explosion-proof control enclosures shall be used to house monitoring and measuring devices in hazardous environments. Enclosures shall be suitable for use in NEC Class 1, Groups C and D or Class II, Groups E, F and G applications and comply with UL and CSA standards.
   c. Required Features:
      1) Light weight and corrosion resistant copper-free aluminum.
      2) Integral, cast-on mounting lugs.
      3) Left side door hinges.
      4) Viewing windows sized to suit internally mounted components.
      5) Stainless steel cover bolts.
      6) Cad-plated steel mounting pans.
   d. Manufacturers: Provide explosion-proof control enclosures of one of the following:
      1) Hoffman
      2) Or approved equal

4. Where the application applies and with the approval of Engineer, wall mounted enclosures may be provided. The enclosure shall comply with Paragraph B.1., or B.2., except for the following:
   a. Locations shall be as shown on or as specified under other Sections.
   b. Panels may be all fiberglass, polycarbonate or ABS.
   c. Doors shall be full height.
   d. Corrosion resistant polyester quick release latches shall be provided.
   e. No extra holes or knockouts shall be provided.

2.3 ENVIRONMENTAL CONTROL

A. Outdoor Panels

1. Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure. Air conditioner shall have a minimum capacity of 4,000 BTU. Housing shall be constructed of corrosion resistant materials.

2. Provide thermostats to automatically control heating and cooling requirements without need of manual operation of a heating/cooling transfer switch.
3. Provide documentation if any of the above is deemed unnecessary.

B. Indoor Panels

1. Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure. Air conditioner shall have a minimum capacity of 4,000 BTU.
2. Provide documentation if any of the above is deemed unnecessary.

2.4 WIRING

A. General

1. Comply with the requirements of Section 40 95 73 “Process Control Wiring”.
2. Internal wiring shall be Type MTW stranded copper wire with thermoplastic insulation rated for 600 V at 90ºC for single conductors, color coded and labeled with wire identification.
3. Wiring shall be clearly marked with an identification number consistent with the wiring schematic.
4. Wiring shall be connected such that if wires are removed from any one device, power will not be disrupted to any other device.
5. Separate and shield low voltage signal wiring from power and control wiring by a minimum of 6-inches.
6. Adequately support and restrain all wiring runs to prevent sagging or other movement.
7. Provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.
8. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of wire insulation.
9. Wiring for devices mounted on the enclosure door or interior dead front panel shall be run in spiral wrap to avoid pinch points when opening and closing the enclosure door(s) or interior panels.
10. Use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.

B. Colors

1. All ungrounded AC conductors operating at the supply voltage shall be “Black”
2. All ungrounded AC control conductors operating at voltage less than supply shall be “RED”
3. All ungrounded DC control conductors shall be “Blue”
4. All ungrounded AC control conductors or wires that remain energized when the main disconnect is in the “OFF” position shall be “Yellow”
5. All grounded AC current carrying conductors shall be “White”
6. All grounded DC current carrying conductors shall be “White with a Blue stripe”

7. All grounded AC current carrying conductors that remain energized when the main disconnect is in the "OFF" position shall be "White with a Yellow stripe"
8. All ground conductors shall be "Green"
9. A wiring color code legend shall be mounted inside the control panel door.

C. Sizing

1. DC signal wiring: No. 18 (min.) AWG shielded
2. DC power wiring: No. 12 (min.) AWG
3. AC signal and control wiring: No. 14 (min.) AWG
4. For wiring carrying more than 15A, use sizes required by NEC standards.

D. Terminal Strips

1. Provide terminal blocks manufactured by Phoenix Contact, or equal.
2. Terminate all field wiring using compression type connectors (soldered type not acceptable) at 600 V rated barrier type terminal strips.
3. Permanently affixed numeric identifiers beside each connection. Identifiers shall be self-stick plastic tape strips with permanent type, machine printed numbers.
4. For DC field signal wiring, terminal strips shall be sized for No. 12 (min.) AWG wiring.
5. For internal component-to-component wiring only, compression type terminal blocks are acceptable.
6. Terminal strips shall not be located closer than 8" from any side or bottom of the control panel. This is designed to allow for adequate wire bending radius for field terminations.
7. Provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (e.g., DC signal and AC power).
8. Provide a separate terminal for grounding each shielded cable.
9. Provide fused terminal blocks, which will provide an LED indictor for a blown fuse. Fused terminal blocks shall be manufactured by Schneider Electric / Square D or equal.

2.5 SURGE PROTECTION

A. General

1. Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate junction box (compatible with the area designation) coupled to the enclosure.

B. Inputs & Outputs

1. Provide plug-in style & DIN-rail mounted devices to allow for easy replacement.
2. Discrete I/O signals shall be protected with solid state surge suppression devices.
3. Analog I/O signals shall be protected by loop powered isolators.

4. MOV-only type surge suppression is not acceptable.
5. Subject to compliance with requirements, provide products by one of the following manufacturers:
    a. Phoenix Contact
    b. Surge Suppression, Inc.
    c. Eaton Crouse-Hinds
    d. Or approved equal

C. Wireless Devices

1. Lightning Protection and surge suppression devices shall be provided for all radio and telemetry equipment. The lightning protection and surge suppression devices shall be manufactured by Phoenix Contact or Engineer approved equal.

D. Incoming Power

1. Provide surge suppression as specified in Section 26 43 13 “Surge Protection for Low-Voltage Electrical Power Circuits”.

E. Programmable Logic Controllers

1. PLC’s shall be protected with a high performance, series-connected EMI/RFI suppression filter to protect the PLC and instrumentation power from high-frequency noise and electrical transients. Noise attenuation for electric line noise shall be 55 dB at 100 kHz using the MIL-STD-220A insertion loss test method. Unit shall be complimentary listed to UL 1283. Products unable to demonstrate noise attenuation of 55 dB at 100 kHz are not acceptable.
2. Subject to compliance with requirements, provide products by one of the following manufacturers:
    a. Surge Suppression, Inc. Model S-SPT120-15
    b. Sola STFV Plus Series
    c. Eaton SPV Series
    d. Current Technology LoadGuard
    e. Emerson Islatrol IC+ Series
    f. Or approved equal

2.6 PANEL MOUNTED DEVICES

A. Selector Switches, Pushbuttons, and Indicating Lights

1. General
    a. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
    b. Type: Heavy duty with full guard, oil tight, 30.5mm, 120VAC, 10A continuous.
    c. Provide legend plate for indication of each switch, pushbutton or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").
    d. Mounting: Flush mounted on control panel front, unless otherwise noted.
    e. NEMA rated to match panel in which mounted.

2. Selector Switches
   a. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.
   b. Contacts
      1) Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.
      2) Type: Double break, silver contacts with movable contact blade providing scrubbing action.
      3) Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than 10A resistive at 120 VAC or DC continuous.
   c. Switch Operator: Standard black knob.

3. Pushbuttons (Standard)
   a. Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.
   b. Contacts: Comply with the requirements specified for selector switches.

4. Pushbuttons (Emergency Stop)
   a. Push-pull actuated
   b. Red mushroom-head
   c. Contacts: Comply with the requirements specified for selector switches.
      1) Provide auxiliary normally-open contacts.

5. Indicating Lights
   a. Type: Compact, LED type.
   b. Lamps: Six volt, long life (20,000 hours minimum).
   c. Common, push to test circuitry shall be provided for each panel to simultaneously test all indicating lights on the panel using a single pushbutton.

6. Button and Lens Colors
   a. Red for indication of closed, on, stopped.
   b. Green for indication of open, off (ready), running.
   c. Amber for indication of equipment malfunction, process trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.).
   d. Blue for indication of electrical control power on.

7. Rotary Cam Switches
   a. Provide rotary cam switches with number of positions and poles as required to perform the required signal switching function specified and shown.
   b. Contacts
      1) Gold-flashed contacts housed in mechanical contact blocks with number and arrangement of contacts as required to perform intended functions.
      2) Contact Rating: Compatible with AC or DC through-put current of signals and devices simultaneously operated by the switch contacts, but not less than 20 A at 600 VAC or 250 VDC continuous.
   c. Switch Operator: Standard black knob.

8. Products and Manufacturers
   a. Allen-Bradley 800T
   b. Eaton Electrical
   c. Cutler Hammer

B. Control Relay

1. Type: General purpose, octal plug-in type rated for continuous duty, DPDT.
2. Construction Features
   a. Coil Voltages: 24 VDC or 120 VAC, as required.
   b. Contacts
      1) Silver cadmium oxide rated not less than 10A resistive at 120 VAC or 24 VDC continuous.
      2) For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 3A resistive at 120 VAC or 28 VDC continuous shall be provided.
   c. Relays to have clear plastic dust cover.
   d. Relays to have pilot light to show energized coil.
   e. Relays to be UL recognized.

3. Products and Manufacturers:
   a. Allen-Bradley 700-HA
   b. IDEC
   c. Or approved equal

C. Time Delay Relay

1. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay on-break or interval operation.
2. Construction Features:
   a. MOS digital circuit with transformer coupled power.
   b. Switch selectable ranges as follows:
      1) One second.
      2) Ten seconds.
      3) One minute.
      4) Ten minutes.
      5) One hour.
      6) Ten hours.
   c. Minimum Setting: Three percent of range, except 50 ms for one-second range.
   d. Setting Knob Accuracy: Ten percent.
   e. Contacts:
      1) Type: DPDT.
      2) Rating: 5 A resistive at 120 VAC, 5 A at 24 VDC.
   f. Housing: Plug-in design with dust and moisture resistant molded plastic case.
   g. Power Input: 120 VAC or 24 VDC as required.
   h. Operating Temperature: 32ºF to 130ºF.
   i. Unit shall have LED to show timing status.
   j. Relays to be UL recognized.

3. Products and Manufacturers:
   a. Automatic Timing and Controls Company.
   b. IDEC.
   c. Or approved equal

D. Power Supplies

1. General: Single unit power supplies, located in control panels, remote terminal units and field panels as required.
2. Single Unit Required Features:
   a. Solid state circuitry
   b. Sized for 1.5 times the application requirements
   c. DIN Rail mounting
   d. Input Power: 120 VAC ±10 percent, 60 Hz
   e. Output Power: 24 VDC or as required
   f. Line/Load Regulation: ±0.005%
   g. Ripple: 0.25 mV RMS
   h. Polarity: Floating output
   i. Ambient Temperature: -4ºF to 160ºF
   j. Response Time: <20µS
   k. Overload Protection: Internal preset
   l. Include mounting brackets, fuse, and mating connector for AC power plug

3. Products and Manufacturers:
   a. Sola / Hevi-Duty
   b. Or approved equal

E. Uninterruptible Power Supply

1. Uninterruptible Power Supply (UPS) shall be furnished to provide a reliable source of uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.
2. Rating: 120 VAC, 60 Hz, 1.4KVA/1.0KW minimum to provide uninterrupted conditioned power, fully loaded conditions for 4 hours minimum.
3. Description: On line dual track power conditioner and true (0ms transfer time) uninterruptible power supply providing isolation, line regulation and conditioning, using sealed 48 VDC maintenance free batteries and switch mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.
4. Required Features:
   a. Lighting and Surge Protection: Inherent 2000: One spike attenuation.
   b. Regulation: One to three percent load regulation with less than 2pF effective coupling capacitance for line to load.
   c. Output Waveform: Computer grade sine wave with three percent maximum single harmonic and five percent maximum total harmonic distortion.
   d. Output Frequency: 60Hz ±0.5Hz.
   e. Operating Temperature: 34ºF to 104ºF.
   f. Relative Humidity: 5% to 90 % non-condensing.

g. Computer Interface: RS232 port for display of 22 meter functions and 15 alarm functions.
h. Input Protection: Independent battery charger fuse and DC fuses.
i. Output Protection: Inherently current limited ferro-resonant transformer.
j. Battery Charger: Two-step charger, 8A and 2A.
k. AC Input: 120VAC, 60Hz, single phase, +15%, -20%.
l. AC Output: 12 VAC, 60Hz, single phase, +3%, -3%.

5. Products and Manufacturers:
   a. Liebert
   b. Or approved equal

F. Digital Indicator

1. General: The digital indicator shall accept an analog input and convert it to scaled numerical characters for digital display and also provide up to two alarm outputs.
2. Required Features:
   a. Display Height: 0.56-inch.
   b. Display Capacity: Four digits with decimal point position jumper selectable.
   c. Display Type: Seven segment, red LED.
   d. Accuracy: ± 0.05%.
   e. Analog Input: 4 to 20mADC.
   f. Excitation Output: 15VDC for powering transmitter.
   g. Analog Output: Proportional 4 to 20mADC.
   h. Alarm Output: Dual with two 2A relays.
   i. Temperature Range: 32ºF to 140ºF
   j. Power: 120VAC, + 10 to -15%, 5W.
   k. Enclosure: NEMA 4 splash proof.

3. Products and Manufacturers:
   a. Red Lion.
   b. Or approved equal.

G. Analog Indicator

1. General: Indicator Unit shall be a signal monitoring instrument that provides continuous monitoring of a process variable on a scaled vertical bar display. Indicator shall match in appearance other panel mounted instruments.
2. Description: Indicator Unit shall display one process variable.
3. Required Features:
   a. Input Signals: 1 to 5VDC (into 10 mega-ohm) or 4 to 20mADC (into 250 ohm range resistor).
   b. Power Required: 21 to 28VDC; nominal input current at 24VDC is 400mA.
   c. Displays: One segmented gas-discharge or LED vertical bar display.
   d. Display Accuracy: One percent of input span.
   e. Scale Length: Approximately 3-inches.
   f. Operating Influences

1) Ambient Temperature: Maintains display accuracy ratings for temperature change within normal operating conditions.
2) Supply Voltage: Maintains display accuracy ratings for supply voltage variation between 21 and 28VDC.
3) Electromagnetic Interference (EMI): Maintains display accuracy ratings when instrument is subjected to an electromagnetic field of up to ten volts/meter (when rack-mounted in cabinet with door closed). Display station must be installed in panel.

g. Operating Conditions
1) Ambient Temperature: 41 to 122ºF.
2) Maximum Temperature Variation: 36ºF per hr.
3) Ambient Relative Humidity: 10% to 90% non-condensing.

h. Mounting: Display station installs in a nominal 1-inch by 6-inch panel cutout and shall match in appearance other panel mounted instruments.

4. Products and Manufacturers
a. Red Lion
b. Or approved equal

H. Elapsed Time Meter (Hour Meter)

1. Unit shall be a powered, non-resettable time indicator, with easy to read analog figures.
2. Required Features
a. Power: 120VAC, or 4 to 40VDC
b. Accuracy: Within one percent
c. Capacity: Up to 99,999.9 hours (automatic recycle at zero); one-tenth hour resolution
d. Operating Temperature: -40ºF to 155ºF
e. Sealed against dirt and moisture
f. Tamperproof
g. Shock resistant
h. Panel mountable
i. Nameplate below display shall read "TOTAL HOURS"

3. Products and Manufacturers
a. Danaher Industrial Controls Group
b. Eaton Electrical
c. Or approved equal

I. Circuit Breakers

1. Molded-case circuit breakers shall be of the same AIC rating as the panel or MCC/Panel to which they are connected/fed from, and shall be required to selectively coordinate above 0.1 seconds.
2. Miniature circuit breakers
a. UL 489 recognized
b. DIN rail mountable
c. Rating: 277/480VAC at 10kAIC

d. "D" curve trip characteristics
e. Cable in-cable out design
f. Products and Manufacturers:
    1) Eaton WMZ line
    2) Or approved equal

J. Fuses

1. Unless otherwise noted the fuse rating and type shall be determined based on the equipment (which the fuse is protecting) manufacturer's recommendations for overcurrent protection.
2. General purpose fuses. Products and Manufacturers:
    a. Ferraz Shawmut UL Power Fuse style
    b. Or approved equal

3. Semiconductor fuses. Products and Manufacturers:
    a. Ferraz Shawmut Amp Trap series fuses
    b. Or approved equal

4. Fuse blocks/holders shall be UL-style fuse blocks manufactured by Ferraz Shawmut or equal.

K. Power Distribution Blocks

1. Block-style distribution blocks shall be provided with polycarbonate safety covers to provide dead front protection. The safety cover shall have a test prod hole for testing purposes.
2. Products and Manufacturers
    a. Ferraz-Shawmut
    b. Or approved equal

L. Electronic Horn

1. The horn shall be of the multi-tone electronic audible type.
2. Required Features
    a. Internal volume control
    b. Field selection of up to 16 different tones
    c. Power: 120 VAC or 24 VDC (provide power supply as required)
    d. Operating Temperature: 32ºF to120ºF
    e. Enclosure Rating: NEMA 4X

3. Products and Manufacturers
    a. Panalarm
    b. Or approved equal

2.7 NETWORK SWITCH

A. General Requirements

1. Ethernet compatible.
2. Copper ports: RJ-45, 10/100Mbps, qty. 4 ports.
3. Fiber port pairs: 1 transmit & 1 receive, 100 Base, multi-mode, 1300nm, SC connectors, qty. 1 pairs.
4. Unmanaged
5. DIN-rail mounted
6. Power: 24VDC
7. Environmental: 0ºF – 140ºF

B. Subject to compliance with requirements provide products by one of the following manufacturers:

1. Hirschmann RS20
2. Stratix 2000
3. Phoenix-Contact
4. Or approved equal

2.8 DIN RAIL

A. General

1. Material: steel
2. Coating: galvanized
3. Color: silver
4. Test standard: in accordance with EN 60715:2001

B. Dimensions

1. Height: 7.5mm
2. Width: 35mm
3. Length: as required

C. Subject to compliance with requirements provide products by one of the following manufacturers:

1. Phoenix-Contact
2. Weidmuller
3. Or approved equal

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Pneumatic tubing shall not be installed inside the process control panels.

B. Locate and install all devices and components so that connections can easily be made and that there is ample room for servicing each item.

C. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at numbered terminal strips, unless otherwise specified.

D. Provide copper grounding studs for all panel equipment.

E. Provide the following convenience accessories inside of each control panel:

1. One 120VAC/20A duplex, GFCI-type receptacle that is accessible from the interior dead-front panel.
2. Service light fixture, minimum one.

    a. LED.
    b. Color temp: 4000K frosted white.
    c. 900 lumens.
    d. Protective clear plastic shield.
    e. Door activated switch.

3. Each service light and receptacle shall have its own dedicated miniature circuit breaker.

F. A main circuit breaker shall be provided for each control panel. Sized as shown.

G. Components for installation on panel exterior shall be located generally as shown. Layouts shall be submitted for review in accordance with Article 1.5 Informational Submittals.

H. Group or bundle parallel runs of wire using plastic covered troughs. Maximum bundle size shall be 1-inch. Troughs shall have 40 percent spare capacity. Install wire troughs along horizontal or vertical routes to present a neat appearance. Angled runs are not acceptable.

I. Alarms generated external to the panel, spare alarm, and repeat contacts shall be wired to terminal blocks.

J. Provide enclosure heater

1. Sized per manufacturer’s recommendations to maintain 60ºF inside enclosure.
2. Rated voltage: 115VAC
3. Thermostatically controlled
4. Fan-driven

3.2 CONTRACTOR'S RESPONSIBILITY

A. The Contractor shall coordinate the work of the service personnel during construction, testing, and acceptance of the work.

B. The Contractor shall receive final approval on all panel, enclosure, and equipment layouts by the Engineer prior to fabrication or installation.

3.3 INSTALLATION

A. All equipment and devices for the work shall be installed in the locations shown on the drawings, in accordance with the manufacturer's recommendations, and in compliance with the requirements of these specifications.

B. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

C. The bottom 12-inches of free standing panels shall be free of all devices, including terminal strips, to provide ease of installation and testing.

D. No device shall be mounted less than 36-inches above the operating floor level, unless otherwise specified.

E. The Contractor shall be responsible for coordinating the installation of all equipment in the proposed locations with all other trades performing work on the project that may be affected.

3.4 FINAL INSPECTION

A. Factory Assembly and Testing

1. Comply with the requirements specified in Section 40 90 00 “Instrumentation and Control for Process Systems”.

B. Include all changes and/or alterations in the control panels prior to final inspection and acceptance by the owner.

C. Any changes and/or alterations in the Control Panels shall be reflected/updated in all Control Panel Schematics prior to acceptance by the Owner. This includes all electronic copies delivered to the Owner.

END OF SECTION 40 95 13

SECTION 40 95 73 – PROCESS CONTROL 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.

B. Related Sections

1. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
2. Section 26 05 33 – Raceways and Boxes for Electrical Systems
3. Section 26 05 53 – Identification for Electrical Systems
4. Section 40 90 00 – Instrumentation and Control for Process Systems
5. Section 40 95 13 – Process Control Panels and Hardware

1.2 SUMMARY

A. Scope

1. Contractor shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install Process Control Wiring.

1.3 DEFINITIONS

A. Abbreviations

1. NEC – National Electrical Code
2. TSP – Twisted shielded pair
3. UL – Underwriters' Laboratories
4. UTP – Unshielded twisted pair

B. Terms

1. 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.
2. 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.

1.4 ACTION SUBMITTALS

A. Comply with the requirements of Section 40 90 00 “Instrumentation and Control for Process Systems”.

B. Product data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports. Comply with the requirements in Part 3 – Field Quality Control.

1.6 CLOSEOUT SUBMITTALS (NOT USED)

1.7 QUALITY ASSURANCE

A. Regulatory Requirements

1. NEC Article 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
2. NEC Article 727, Instrumentation Tray Cable.
3. Tests by Independent Regulatory Agencies: Cable shall bear the label of Underwriters’ Laboratories, Inc.

B. Referenced Standards

1. UL 1581, Electrical Wires, Cables and Flexible Cords.
2. UL 13, Power-Limited Circuit Cables.
3. UL VW-1, Vertical Wire Flame Test.
4. NECA 1-2013: Good Workmanship in Electrical Contracting (ANSI)
5. NFPA 70-2014: National Electrical Code

1.8 FIELD CONDITIONS (NOT USED)

PART 2 - PRODUCTS

2.1 Single Shielded Pair Instrument Cable

A. Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, twisted pair with overall shield, stranded tinned No. 18 AWG copper drain wire and overall chrome PVC jacket. Rated for 600 volts minimum and conforming to UL 1581.

B. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Belden Company.
2. Okonite Company.
3. Dekoron Wire and Cable Company.
4. Or equal.

2.2 Multi-paired Shielded Instrument Cable

A. Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, twisted pairs with shield over each pair, stranded tinned No. 18 AWG copper drain wire, and overall PVC outer jacket. Rated for 600 volts minimum and conforming to UL 1581 or UL 13.

B. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Belden Company.
2. Okonite Company.
3. Dekoron Wire and Cable Company.
4. Or equal.

2.3 Multi-conductor Shielded Instrument Cable

A. Tinned copper, XLPE insulated stranded conductors, No. 16 AWG minimum, stranded tinned #18 AWG copper drain wire, with overall 100 percent foil shield and overall chrome PVC jacket. Rated for 600 volts minimum.

B. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Belden Company.
2. Okonite Company.
3. Dekoron Wire and Cable Company.
4. Or equal.

2.4 Multi-conductor Shielded High-Temperature Instrument Cable

A. Silver-plated copper, extruded Teflon insulation, stranded conductors, No. 16 AWG minimum with overall 90 percent silver-plated copper braid shield and overall Teflon tape-wrapped jacket. Rated for 600 volts minimum and conforming to UL VW-1.

B. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Belden Company.
2. Okonite Company.
3. Dekoron Wire and Cable Company.
4. Or equal.

2.5 Multi-conductor Shielded Plenum-Rated Instrument Cable

A. Tinned copper, fluorinated ethylene-propylene (FEP) insulation, stranded conductors, No. 16 AWG minimum with overall foil shield plus 85 percent tinned copper braid shield and overall FEP jacket (non-conduit).

B. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Belden Company.
2. Okonite Company.
3. Dekoron Wire and Cable Company.
4. Or equal.

2.6 Cable Terminals

A. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

B. Subject to compliance with requirements, provide products by one of the following manufacturers:

1. T&B Sta-Kon.
2. Burndy Insulug.
3. Or equal.

2.7 9/125 MICROMETER SINGLE-MODE, OUTSIDE PLANT OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, 12-fiber, stranded loose tube, optical fiber cable.

B. Standards

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-87-640 for mechanical properties.

C. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

D. Jacket

1. Jacket Color: Black.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.8 62.5/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM1)

A. Description: Multimode, 62.5/125-micrometer, 12-fiber, conductive tight buffer, optical fiber cable.

B. Standards

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAA for detailed specifications.

C. Conductive cable shall be aluminum armored type.

D. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

E. Minimum Overfilled Modal Bandwidth-Length Product: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

F. Jacket

1. Jacket Color: Orange.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
2. Riser Rated, Nonconductive: Type OFNP or Type OFNR in listed riser or plenum communications raceway.
3. Riser Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
4. Riser Rated, Conductive: Type OFCR; complying with UL 1666 and ICEA S-103-701.
5. Riser Rated, Conductive: Type OFCP, Type OFNP, or Type OFCR or Type OFNP in listed riser or plenum communications raceway.
6. Riser Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit.

2.9 OPTICAL FIBER CABLE HARDWARE

A. Standards

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Connector Type: Type ST complying with TIA-604-2-B connectors.

E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1 and NFPA 70.

B. General Requirements

1. Install cable complete with proper terminations at both ends.
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at locations shown on Drawings.
3. Cables may not be spliced.
4. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Bond shielding on shielded cables at one end only at the PLC control panel and as recommended by instrument manufacturer.
7. Comply with requirements in Section 26 05 53 “Identification of Electrical Systems”.
8. Install and terminate vendor furnished cable in accordance with vendor equipment requirements and cable manufacturer’s recommendations.

C. Installation in Raceways

1. Comply with requirements specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."
2. Install in conduit separate from power cables, unless specified otherwise.

D. Installation in Control Panels

1. Comply with requirements specified in Section 40 95 13 “Process Control Panels and Hardware”.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections

1. Comply with requirements in Section 26 05 19 “Low-Voltage Electrical Power Conductors and Cables”.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test shielded instrumentation cable shields with an ohmmeter for continuity along the full length of the cable and for shield continuity to ground.
4. Connect shielded instrumentation cables to a calibrated 4 to 20 mADC signal transmitter and receiver. Test at 4 and 20 milliamp transmitter settings.
5. Cable that fails a test shall be replaced with a new cable for its full length.

B. End-to-end cabling will be considered defective if it does not pass tests and inspections.

C. Document data for each measurement.

D. Prepare test and inspection reports.

END OF SECTION 40 95 73

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SECTION 41 22 23.19

HOISTING EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test hoisting equipment, motors, gear reducers, controls and appurtenances as indicated and in compliance with Contract Documents.

1. Rail and supporting beams included in building structure, refer to structural drawings.

2. Hoist capacities and operating data are indicated in the Hoisting Schedule.

1.02 REFERENCES:

A. American Bearing Manufacturers Association (ABMA):

1. 9: Load Ratings and Fatigue Life for Ball Bearings.

2. 11: Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of mechanical Engineers (ASME):

1. B30.16: Overhead Hoists (Underhung) Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

C. American Welding Society (AWS):

1. D1.1: Structural Welding Code Aluminum.

D. National Electric Code (NEC).

E. National Electrical Manufacturers Association (NEMA):

1. MG1: Motors and Generators.

F. Occupational Safety and Hazard Association (OSHA):

1. 29 CFR 1910.179: Overhead and Gantry Cranes.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding hoisting equipment characteristics and performance:

2. Certified setting plans, with tolerances, for anchor bolts.

3. Manufacturer's literature as needed to supplement certified data.

4. Operating and maintenance instructions and parts lists.

5. Listing of reference installations as specified with contact names and telephone numbers.

6. List of recommended spare parts other than those specified.

7. Shop and field inspection reports.

8. Motor shop test results.

9. Qualifications of field service engineer.

10. Recommendations for short and long-term storage.

11. Shop and field testing procedures, equipment to be used.

12. Special tools.

13. Number of service person-days provided and per diem field service rate.

14. Manufacturer's product data, specifications and color charts for shop painting.

15. The latest ISO 9001 series certification.

16. Provide Certificate of Responsibility. See Section 01 33 00 for Certificate form.

17. Provide scaled drawing height and weight of equipment serviced by the hoisting equipment including hook height and travel dimensions.

18. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and designed for the service conditions specified and indicated.

C. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Permanently mark the capacity of the hoist and trolley on each hoist, in easy to read letters and in a prominent position.

C. Provide only safety type hooks.

D. Provide hoists so that hook can reach the floor at the lowest level of the lift.

E. Do not use hoists for construction purposes of any nature.

F. Hoists shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

G. Welding: In accordance with American Welding Society Code D1.1.

H. Provide shop tests as specified.

I. Hoisting equipment manufacturer shall provide hoists, motors, gear reducers, switches, and controls regardless of manufacturer as a complete integrated package to ensure coordination, compatibility and operation of the systems.

J. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.

K. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping and electrical:

a. 0.5 person-days.

3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.

a. 0.5 person-days.

4. Performance Testing: Field performance test equipment specified.

a. 0.5 person-days.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

a. 0.5 person-days.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

L. Manufacturer of hoisting equipment shall have a minimum of five (5) operating installations with hoists of the size specified and in the same service as specified operating for not less than five (5) years.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Hoisting equipment capacities and operating data are indicated in the Hoist Schedule.

2.02 HOIST AND TROLLEY MANUFACTURERS:

A. Dresser Industries.

B. ACCO-Wright.

C. Yale Hoisting Equipment Division.

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 MANUAL HOISTS:

A. Hoist Mechanism: Fully enclosed high-speed, spur-geared, ball or roller bearing, hand-operated, chain hoist with a retaining brake or other acceptable device built into hoisting mechanism.

B. Hooks: High grade, forged steel with swivel, antifriction bearings.

C. Load Wheel: Make with accurately formed chain pockets to fit load chain.

D. Hoist Operating Wheel: A load limiting clutch mechanism consisting of spring loaded rollers that run between an outer race and an inner hub mounted on the outside of the wheel. The clutch shall be designed to limit the chain pull to not more than 150 percent of that required to lift the rated load capacity of the hoist. Provide with chain guides with chain of sufficient length to hang 3 feet above operating floor.

E. Chain Bucket: Provide where specified to collect load chain. Arrange chain bucket so it will not interfere with smooth operation of hoist.

F. Lightweight Hoists: Make with high strength aluminum frame, hand wheel and housing.

G. Provide each hoist with a clevis connection for use with a trolley, a suspension hook at top, or be integrally built into trolley as indicated on drawings or specified herein.

2.05 ELECTRIC HOISTS:

A. Electric Hoists: Spur-gear driven antifriction bearings throughout, a mechanical load brake, and a separate electrically operated motor brake. Design mechanical load brake with capability of supporting the full load at any point when the motor is stopped. Motor brake shall be externally adjustable, electrically operated friction disk brake that shall apply automatically when the power is off. The brake shall hold 150 percent of the rated load and 125 percent of the rated load at any operating speed. Design shafts of motor, drum, and drum pinion to run in grease-lubricated ball or roller bearings. Design the mechanical-load brake and gear train and bearings to be oil-bath lubricated.

B. Arrange hoist for parallel lug mounting from a 4-wheel geared trolley.

C. Provide hoist with right angle mounting with H-wheel trolley, motorized as specified and indicated.

D. Hoist: Standard type.

E. Hoist: Low headroom type meeting the requirements of ASME B30.16.

F. Design drum with machine-cut grooves and guarded flanges and with capacity to take entire run of cable in one layer with no overlapping.

G. Provide hoist with an upper and lower geared limit switch with automatic reset control circuit to prevent overtravel. Settings to be field adjustable in accordance with OSHA 29 CFR 1910.179.

H. Supply sufficient hoisting cable with hoists for two-part single reeving and to accommodate not only the maximum lift but two additional wraps on drum. Make cable flexible high-strength plowsteel cable with a load safety factor of at least 5 to 1.

I. Make load block of rugged construction containing a ball-bearing sheave and a high-grade forged-steel swivel hook with antifriction bearings.

J. Provide control equipment in an enclosed compartment which forms an integral part of hoist and include a transformer for a 120-volt control circuit.

K. Hoist for Grit Chamber Clam Shell Bucket: Self-contained unit consisting of single-wire rope winch, a twin-wire rope winch and appurtenances, all mounted on a motor-driven trolley. Have twin-wire winch operate the bucket holding line, and the single-wire winch operate the closing line. Design bucket and the holding line with two wire cables leading to an equalizer bar on bucket. Supply sufficient hoisting cable to accommodate not only maximum lift for each winch but additional length of closing line necessary for reeving clamshell bucket plus two extra wraps on drums.

2.06 TROLLEYS:

A. Manual Trolleys: 4-wheel type fabricated from heavy steel or aluminum sections with sides extending beyond wheel flanges to provide bumper protection. Design wheels with machined treads surface-hardened and set at proper angle to bear load evenly on supporting beam flanges. Provide wheels with lifetime lubricated ball or roller bearings.

B. Plain Trolleys: Push type with a hole for attaching suspension hook.

C. Army Type Hoists: Close headroom type, integrally built into a 4-wheel plain or geared trolley.

D. Provide trolley operating wheels with chain guides and make chains for each of sufficient length to hang 3 feet above operating floor.

E. Motor-Driven Trolleys: Four-wheel type consisting of a fully enclosed electric motor equipped with a magnetic brake, a geared transmission completely enclosed in an oil-tight housing and suspended on flanged driving wheels with power to two wheels. Use ball or roller bearings throughout.

F. Make trolleys designed for operation on beam or rail indicated on drawings. Trolleys to be provided by the hoist manufacturer.

2.07 JIB CRANE:

A. Jib Crane Manufacturers:

1. ACCO-Wright.

2. CONTRX

3. Dresser Industries, Inc., Hoist & Tower Div.

4. Ohio Hoist & Mfg. Co., Inc.

B. Jib Crane: Steel S-beam boom, with an adjustable tie rod brace, a hinge-bracket or bar support for both boom and tie rod which permits 180 degrees swing. Fix safety stop at outer end of boom to prevent trolley from running off open end.

C. Jib Crane: Vertical steel post of extra heavy steel pipe installed in a vertical position, with an S-beam mounted at top of post and capable of revolving completely around it, and a trolley-type hoist.

D. Base: Special casting adequate to support crane with its maximum load on hoist at extreme end of trolley beam.

2.08 DAVIT:

A. Make davit as indicated on drawings. Make davit of steel and brackets of malleable iron.

2.09 SWITCHES AND SWING-OUT SECTIONS:

A. Manufacturers:

1. American Monorail Co.

2. Richards-Wilcox Mfg.

3. ACCO-Louden Switches: Glide or sliding type, manually operated. Design transfer mechanisms and locking devices capable of positioning switch to maintain true vertical and horizontal alignment of track and conductors and prevent switch operation when any part of trolley is in switch.

B. Furnish swing-out sections at roll-up doors as indicated on drawings.

2.10 SAFETY STOPS:

A. Provide safety stops on all open ends of track (or where indicated) to prevent trolley from running off ends or damaging building. Provide stops with capability of withstanding impact imposed by motion of fully loaded hoist and trolley.

2.11 TRACK:

A. Monorail Track: Standard beam of sizes indicated on drawings.

B. Shop fabricate all curves for either track or switches to radius indicated.

C. Erect track level throughout, with section ends machined fitted and spliced with web-type or other designed couplings to provide flush level connections. Maximum gap between adjacent ends not exceeding 1/16 inch.

2.12 PORTABLE GANTRY:

A. Portable Gantry: Four-leg rolling-type gantry with capacity as indicated. Horizontal standard aluminum beam suspended at each end by pipe legs adjustable for both height and span at floor, adequately braced, with locking swivel casters for each leg.

B. Position legs and span by pins provided with springs and a locking device to fit matching holes in telescoping pipe members.

C. Fit casters with ball bearings and wheels of rubber plastic treads designed for rated capacity of gantry.

D. Provide stops at ends of beam to prevent trolley rolloff.

2.13 CABLE REELS:

A. Manufacturers:

1. Gleason Reel Div.

2. Aero-Motive Mfg. Co.

3. Liftech.

B. Furnish junction box to connect cable reel to power supply circuit with hoist.

2.15 ELECTRICAL CONTROLS:

A. Supply complete integral electrical control system with the electric hoisting equipment (by hoist manufacturer) consisting of starters, circuit breakers, overload relays, limit switches, control transformer for a 120-volt control circuit, control relays, and controlling devices.

B. Furnish magnetic controls for motors. Design controls to permit "inching" in both forward and reverse directions under full load, automatically regulated acceleration, and rapid brake response.

C. Provide each hoist with limit switches of automatic-reset control circuit type to prevent overtravel in both raising and lowering directions.

D. Compliance: Make all electrical equipment including motors, controls, resistors, brakes plus all conduit, wiring, panels, and enclosures with applicable requirements for materials, workmanship, construction, and installation of latest NEMA and National Electrical Code Standards.

2.16 MOTORS:

A. Provide in accordance with Section 26 20 00 and as specified herein.

B. Motors for Hoists and Trolley: Totally enclosed, reversible, induction motors especially adapted to hoist service.

1. Enclosure: As indicated in the Hoist Schedule.

2. Insulation: Minimum Class “F” with Class “B” temperature rise, 40 degrees C ambient unless otherwise indicated or specified.

3. Service Factor: 1.15.

4. Provide capacity to start and operate hoists at maximum speed rated capacity indicated without exceeding nameplate ratings for current and power and without operating in the service factor.

5. Provide ball or roller bearings, in accordance with ABMA Standard 9 and Standard 11; minimum L-10 life of 100,000 hours.

6. Premium efficient motors, nominal and minimum motor efficiencies per NEMA MG1.

7. Rating: 460V, 3-phase, 60 Hertz.

2.17 PUSHBUTTON CONTROL:

A. Provide pendent pushbutton control station with sufficient pushbuttons to control all operations of hoists and trolley. Clearly mark each pushbutton to indicate its function. Make cable long enough to reach within 4 feet of operating floor or platform level with a supporting chain. If necessary, attach an arm to hoist so that pendent cable and pushbutton controls will hang vertically and be readily accessible from operating positions.

B. Controls for Wound-Rotor Motors: Five-step, full magnetic type. Design all other controls to be designed for single-speed motors.

C. Use five-step, full magnetic type controls for hoisting and closing-line motors for grit chamber. Use single-speed motor controls for trolley drive and chlorination room hoist.

D. For control of pump building hoist, use a five-step pushbutton station operating magnetic controls to provide automatically regulated acceleration and rapid brake response.

E. For pushbutton station for rack building hoist use two-step control suitable for Hazardous Classified spaces as depicted on the project documents.

F. Provide hoist with an upper limit switch of automatic reset control circuit type to prevent overtravel.

2.18 CONDUCTORS AND COLLECTORS:

A. Manufacturers:

1. Insul-8-Bar Protected Conductors made by Insul-8-Corp.

2. Safety-T-Bar Conductor Systems made by Howell Corp.

3. Duct-O-Bar Conductor System made by Duct-O-Wire Co.

B. Use equipment and accessories approved by Underwriter's Laboratories (UL).

C. For conductor for electric current supply use safety type in which conductor is shielded by a molded-plastic cover that surrounds conductor except for a slotted opening shaped to contour of

collector head. Provide separate conductor for each phase. (Dual conductors in a single insulating shield are not acceptable). Make conductor of plated steel or copper designed for carrying maximum anticipated current. Make molded-plastic shield of high dielectric strength, rigid yet sufficiently flexible to permit bending to radius of curves or switches, and resistant to corrosion and deterioration from sunlight or weather. Space insulated supports not over 5 feet on straight track and 3 feet on curves.

D. Provide weather shield for exterior conductors.

E. Use collectors of sliding shoe type with an adjustable spring-load arm capable of horizontal or vertical movement to automatically adapt to irregularities of conductor. Set shoe in a molded-plastic head that will prevent external contact with shoe when it is running on conductor. There shall be no exposed bare current-carrying surfaces or wires in collector or arm where shoe is in contact with conductor.

2.19 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10 Shop Painting and 09 96 00 High Performance Coatings.

B. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer’s printed instructions and as specified.

C. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

D. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with manufacturer's printed instructions and as indicated and specified.

B. Check horizontal and vertical alignment of track and rails.

C. Erect rack level throughout, with section ends machined fitted and spliced with web-type couplings to provide flush level connections. Maximum gap between adjacent ends not exceeding 1/16-inch.

D. Do not use cast fittings.

3.02 FIELD TESTING:

A. Provide as specified herein. Perform all tests with instrumentation controls and motor controls. Perform testing in accordance with OSHA 29 CFR 1910.179 and as specified herein.

B. After installation of hoist equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service technician, conduct test for each hoist in presence of the Engineer to determine its ability to operate at rated speeds and capacity under

conditions specified and indicated. During tests, observe and record, capacity and motor inputs. Promptly correct or replace all equipment not conforming to the requirements of this section revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results are obtained. Contractor to provide all labor, weights and materials for conducting tests.

1. Provide a 60 minute test for each hoist.

2. Running test shall consist of moving hoist and trolley through two complete cycles. The first cycle will be with no load. For the second cycle, the unit will be loaded with 100 percent of the specified load rating.

3. Test and simulate all limit switches, locking and safety devices.

C. Make all adjustments to place equipment in specified working order at time of above tests.

D. After three (3) unsuccessful testing attempts, remove and replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and testing, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 41 22 23.19

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SECTION 43 21 00

SUBMERSIBLE PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test submersible pumps, motors, discharge base elbow, variable frequency motor controllers and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Bearing Manufacturers Association (ABMA):

1. 9: Load Ratings and Fatigue Life for Ball Bearings.

2. 11: Load Ratings and Fatigue Life for Roller Bearings.

B. ASTM International (ASTM):

1. A36/A36M: Standard Specification for Carbon Structural Steel.

2. A48/A48M: Standard Specification for Gray Iron Castings.

3. A576: Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

4. A743/A743M: Standard Specification for Castings, Iron-Chromium, Iron-Chromium Nickel, Corrosion Resistant, for General Application.

5. D2240: Standard Test Method for Rubber Property – Durometer Hardness.

C. American National Standards Institute (ANSI):

1. B16.1: Standard for Cast Iron Pipe Flanges and Flanged Fittings, 125 lb.

D. Hydraulic Institute (HI):

1. Current Standards.

2. 11.6: Submersible Pump Tests

E. National Electrical Manufacturers Association (NEMA):

1. MG1: Motors and Generators.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding pump and motor characteristics and performance:

a. Prior to fabrication and testing, provide manufacturer's guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, efficiency and $NPSH_3$.

(1) For units of same size and type, provide curves for a single unit only.

b. Provide catalog performance curves at maximum pump speed indicated and specified for each service showing maximum and minimum impeller diameters available, acceptable operating range (AOR) and preferred operating range (POR).

c. Results of shop performance tests as specified.

d. Submit curves for manufacturer's guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch sheets, one curve per sheet.

2. Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide $NPSH_3$ curve for each speed.

3. Shop drawing data for accessory items.

4. Certified setting plans, with tolerances, for anchor bolts.

5. Manufacturer's literature as needed to supplement certified data.

6. Operating and maintenance instructions and parts lists.

7. Listing of reference installations as specified with contact names and telephone numbers.

8. Certified results of hydrostatic testing.

9. Certified results of dynamic balancing.

10. List of recommended spare parts other than those specified.

11. Shop and field inspection reports.

12. Bearing Life: Certified by the pump manufacturer. ~~***Include design data***~~.

13. Pump shop test results.

14. Motor shop test results.

15. Qualifications of field service engineer.

16. Recommendations for short and long-term storage.

17. Resonant frequency analysis.

18. Shop and field testing procedures, pump and piping set up, equipment to be used and ANSI/HI testing tolerances to be followed.

19. Special tools.

20. Number of service person-days provided and per diem field service rate.

21. Results of shop vibration test data for each pump and drive assembly.

~~***22. Recommended location of discharge pressure gauges.***~~

23. Manufacturer's product data, specifications and color charts for shop painting.

24. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

25. The latest ISO 9001 series certification.

26. Provide a scaled drawing for each pump service showing the pumps, motors, hoists and bridge cranes including equipment weights, lifting attachments, slings and clearances for equipment removal and maintenance.

27. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

    1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

    1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. For each pump:

a. One complete set of gaskets and O-rings.

b. One set of wearing rings.

c. Complete mechanical seal assembly

d. Complete set of bearings

2. For each set of pumps of the same size and performance.

a. One set of all special tools required.

~~***3. Provide spare pumps and rotating assemblies as presented in the Process Pump Schedule.***~~

~~***a. Spare Rotating Assemblies: Provide the assembly including volute, impeller, motor and control and power cables of the length as provided for all pumps.***~~

4. Submit Operations and Maintenance Data in accordance with Section 01 78 23 for all products specified under this section.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Pumps shall be the product of one manufacturer.

C. Pumps shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.

E. Shop tests as specified.

F. The Contractor shall obtain the pumps, motors and appurtenances from the pump manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

1. Variable frequency motor controllers can be supplied by the Contractor or the pump manufacturer at the Contractor's option. The pumping system must be a complete and integrated package to insure proper coordination and compatibility and operation of the system.

    a. The Contractor shall coordinate the variable frequency motor controllers with the pump and motor manufacturer and submit as part of the shop drawings a written statement signed by the Contractor, pump manufacturer, motor manufacturer and variable frequency motor controller manufacturer that the variable frequency motor controller manufacturer has received the required information from the pump and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also include all motor data and information that has been used for the coordination.

    b. Provide variable frequency motor controllers in accordance with Section 26 29 23.

2. Guide cables or rails and hatches can be supplied by the Contractor or the pump manufacturer at the Contractor's option. The pumping system must be a complete and integrated package to insure proper coordination and compatibility and operation of the system.

    a. The Contractor shall coordinate the hatch size with the pump manufacturer and submit as part of the shop drawings a written statement signed by the Contractor and pump manufacturer that the Contractor has received the required information from the pump manufacturer and that all parties have reviewed the hatch size and coordinated the hatch size, bridge crane and equipment removal.

    b. The Contractor shall coordinate the cable or rail size with the pump manufacturer and submit as part of the shop drawings a written statement signed by the contractor and pump manufacturer that the Contractor has received the required information from the pump manufacturer and that all parties have reviewed the cable or rail size and coordinated the size and equipment removal.

G. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.

H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping and electrical:

    a. 1 person-days.

3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

    a. 1 person-days.

4. Performance Testing: Field performance test equipment specified.

a. 1 person-days.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

a. 1 person-days.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

I. Manufacturer of pumps shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

J. If equipment proposed is heavier or taller, different rotation, or discharge arrangement than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

K. For variable speed pump systems the pump manufacturer must perform an analysis of the combined motor and pump assembly for resonant frequency or their harmonics independent of a structure.

1. Submit a copy of these calculations for the record.

2. Should calculations indicate the probability of encountering such frequencies within the speed range required, provide all additional supporting devices necessary to affect the unit mass, and raise or lower resonant point to be within the speed range required.

3. Provide and install such additional devices at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the ***~~Process~~*** Pump Schedule ***on the drawings***.

B. Lift Station Pumps: Pump spent deicing fluid from lift station wet well. Before entering the lift station, spent deicing fluid will normally pass through a wedge wire screen with ½ inch clear openings.

C. Drainage pump: Pump remaining spent deicing fluid in the lift station to drain the wet well.

D. Equipment Limitations:

a. Maximum Total Pump and Motor Weight for Lifting: 3,500 lbs.

b. Maximum Overall Pump Assembly Length: 120 in.

E. Coordinate pump dimensions and weights with hoists as specified in Sections 41 22 23.19 and as indicated.

F. Design pumps so that future conditions specified can be achieved by:

1. Installation of future impellers only.

2. Installation of future motors only.

2.02 MANUFACTURERS:

A. Submersible Solids Handling Pumps

1. Xylem Flygt

2. Hayward Gordon

3. KSB

4. Sulzer/ABS

5. Or Equal

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 PUMP CONSTRUCTION:

A. Pumps: Solids handling single-stage, rotodynamic pumps, close coupled to submersible motors.

B. Design and proportion all parts of pump specially adapted for the service specified and indicated.

C. Pump Mounting: Provide type as indicated and specified.

1. Mount each pump on a discharge elbowdischarging vertically.

~~***2. Mount each pump and a discharge connection discharging horizontally.***~~

D. Pump Casing, Fronthead, Backhead and Lower Housing:

1. Cast iron ASTM A48 Class 35.

2. Provide lifting devices on pump/motor assembly for handling.

a. Type 316 stainless steel.

3. Provide ribs or reinforcing if required to withstand the specified hydrostatic test pressure, to prevent deflection caused by hydraulic thrust and to support the motor.

4. Face and drill flanges of discharge connections in accordance with 125-lb ANSI/ASME B16.1 Class 125 Standard.

5. Where a rail pipe is required face and drill suction in accordance with 125-lb ANSI/ASME B16.1 Class 125 Standard.

6. Provide components with machined registered concentric shoulder fits for precision alignment. Equipment without registered fits is not acceptable.

7. Provide a single piece volute, non-concentric design with centerline discharge.

8. Provide all passages smooth and large enough to pass any solids that may enter the impeller.

9. Provide suction and discharge nozzle sizes as indicated in the ~~Process Pump Schedule~~ ***Drawings.***

10. Provide the discharge flange design to permit attachment to standard ANSI flanges and appurtenances as specified and indicated

11. Provide the discharge flange solid with the specified bolting arrangement or slotted to accept ANSI flanged fittings.

12. Proprietary or non-standard flange dimensions are not acceptable.

13. Pumps with splitter vanes in casing are not acceptable unless specifically indicated in the ~~Process Pump Schedule~~ ***Drawings****.*

14. Lining

a. Manufacturer:

(1) Belzona Supermetalglide

(2) Devcon Brushable Ceramic BlueType: Ceramic filled epoxy

c. Percent Solids by Volume: 100 percent

d. Provide two coats 8 to 15 mils (200 to 380 microns) thick with total minimum DFT of 20 mils (500 microns).

e. Cured Hardness: 90D in accordance with ASTM D2240

f. Surface preparation, mixing and application and safety requirements shall be in accordance with the lining manufacturer's printed instructions and as specified.

E. Impeller:

1. General:

a. Provide the impeller with a slip fit onto the motor shaft and drive key ***or a conical locking mechanism,*** and fastened to the shaft by a Type 416 stainless steel or Type 316Ti stainless steel bolt mechanically prevented from loosening by a positively engaged ratcheting washer assembly.

b. Provide the head of the impeller bolt recessed within the impeller bore to prevent disruption of the flow stream and loss of hydraulic efficiency.

c. Impeller designs that do not pass a the minimum spherical solid size specified and indicated, those that rely on retractable impeller designs to pass the spherical solid size specified and indicated, or those that rely on fins or pins protruding into the suction path to assist in the handling of fibrous material are not acceptable.

d. Dynamically balance impellers to ISO 21940 Grade G6.3

e. Provide impellers not greater than 95 percent ~~***or the percentage indicated in the Process Pump Schedule***~~, of the maximum diameter impeller available.

f. Do not design hub with ports for reduction of thrust on impeller.

g. Statically and dynamically balance each impeller.

h. Provide vanes having wide suction and waterways that will pass solids and stringy without clogging.

i. Where single vane pumps are indicated, multi-vane pumps are not acceptable.

~~***j.***~~ Provide pumps capable of passing a ***3-inch*** sphere. ~~***size as indicated in the Process Pump Schedule.***~~

2. Semi Open:

a. Semi-open, solids handling, single and two vane design ~~as indicated in the Process Pump Schedule,~~ with a minimum spherical, non-deformable solids passage **of a 3-inch sphere**.

b. Materials:

(a) ASTM A-48 Class 35B Cast Iron with Melonite liquid nitriding treatment or Hard-Iron ASTM A-532 (Alloy III A) 25 percent chrome cast iron.

c. Self-Cleaning Bottom Plate:

(1) Provide a bottom plate designed with an inlet incorporating cutting ***or relief*** grooves and an outward spiral V-shaped groove on the side facing the impeller, ***~~to shred~~*** and force stringy solids outward from the impeller and through the pump discharge.

(2) Provide the bottom plate mounted to the volute with ***~~three~~*** stainless steel locking screws and ***~~three~~*** stainless steel adjusting screws to permit close tolerance adjustment between the bottom plate and impeller for maximum pump efficiency ***or adjusts clearance via impeller .***

(3) Provide the bottom plate externally adjustable with standard tools and without any need to disassemble the pump ***where applicable.***

(4) Materials: ASTM A-48 Class 35B Cast Iron with Melonite liquid nitriding treatment or Hard Iron

3. Enclosed Impellers:

a. Material:

(1) Provide Stainless steel ASTM A743/A743M Grade CA-6NM (13 percent Cr, 4 percent Ni-Mo) or CD4MCu impellers for all pump services except as specified herein.

(2) Cast Iron, ASTM A48 Class 35 with ceramic coating as specified above for pump casing.

b. Wearing Rings:

(1) Provide on impeller and in pump casing at suction side.

(2) Pumps larger than 24-in: Type 410 stainless steel 450-490 BHN or Type 440 Stainless Steel with a 600 BHN.

(3) Impeller and Casing Wearing Rings for all other pumps:

(a) Impeller: Stainless Steel ASTM A743/A743M Grade CA-40 with a 300 to 350 BHN.

(b) Casing Wearing Rings for all other pumps: Stainless Steel ASTM A743/A743M Grade CA-40 with a 450 to 480 BHN.

2.05 MOTORS:

A. Provide in accordance with Section 26 20 00 and as specified and indicated.

B. Horsepower rating of motors: Not less than maximum brake horsepower requirements of pumps under any condition of operation specified and indicated without operating in the motor service factor.

C. Motor speed: As stated in the ***Process*** Pump Schedule**.**

D. Enclosure: Explosion proof, Class I, Division 1, Group D; UL or FM certified.

E. In addition to the requirements for bearings specified under Electric Motors in Section 26 20 00, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

F. Operate without overheating at the speeds specified and indicated.

G. Service Factor: 1.15, with 1.0 inverter duty rating for pumps equipped with variable frequency motor controllers.

H. Minimum ***Motor*** Efficiency ~~***for Lift Station Pumps (SD-LP-1, 2, 3):***~~

~~***1. 100 percent Load: 91.0%***~~

~~***2. 75 percent Load: 91.5%***~~

~~***3. 50 percent Load: 90.5%***~~

1. All motors will be NEMA Premium Efficiency rated.

I. Rating: 460V, 3-phase, 60 Hertz.

J. Insulation: Class H with Class B temperature rise, 40 degrees C ambient.

K. Site Altitude: Less than 3,300 feet (1,000 metres) above sea level.

L. Motors:

1. Provide complete sealed electric submersible squirrel cage induction motors in accordance with the above and as specified herein.

2. Provide all components housed in an air or oil filled cast-iron watertight electric submersible squirrel cage induction motor in accordance with the above and as specified herein.

3. Provide a closed loop cooling system which circulates a non toxic oil or glycol-water mixture through a cooling jacket surrounding the motor, and through an integrated heat exchanger to transfer the motor heat to the process fluid.

4. Insulate stator-winding and lead with moisture resistant Class F or Class H insulation for continuous duty in 40 degrees C rise liquids.

5. Provide motor capable of ten (10) starts per hour at maximum speed.

6. Motor shaft: Type 416**, *Type 431*** or Type 420 stainless steel or ASTM A576 Cr 1040 with Type 420 stainless steel sleeve.

    a. One piece internal pump/motor shaft.

    b. Provide shaft of sufficient diameter that the ratio of the shaft overhand, distance from lowest bearing to the impeller hub, to the shaft diameter through the seal area not to exceed 2.5.

7. Dynamically balance rotor to within NEMA vibration limits.

8. All hardware: Type 316 stainless steel.

9. Provide all cables of multi-conductor SOW-A, G-GC or W of sufficient length to extend from pump motor to a junction box. Cable size shall be in accordance with NEC specifications.

10. Cable Entry:

    a. Provide all power and control lead wires double sealed entering the motor in a method that prevents cable wicking.

    b. Provide the sealing system consisting of a rubber grommet to seal the cable exterior followed by interior epoxy seal.

    c. Provide each cable wire with a section of insulation removed to establish a window area of bare wire and each wire surrounded by epoxy potting material ***or allow for a terminal board seals to seal the stator housing from the junction housing.***

    d. Provide a cable strain relief mechanism as an integral part of this sealing system.

    e. Provide the cable sealing system capable of withstanding an external pressure test of 1,200 psi (830 kPa) as well as a cable assembly pull test as required by UL or FM.

    f. Provide the cable entry rated by UL or FM for submerged operating depths to ***~~85 feet (26 meters)~~ 65 feet.***

    g. Singular grommet or other similar sealing systems are not acceptable.

11. Seals:

    a. Provide two separate tandem-mounted mechanical seals with the upper and lower seals mounted to rotate in the same direction.

    b. Upper Seals:

        (1) Provide seal completely immersed in an oil or glycol bath sealing the oil chamber and motor housing.

        (2) Materials: Silicon carbide or tungsten carbide rotating and stationary faces.

c. Lower Seals:

(1) Provide lower seal with mating faces immersed in the oil or glycol bath sealing the pump volute and oil chamber.

(2) Materials: Silicon carbide ***or tungsten carbide*** rotating and stationary faces.

(3) Provide a cover extending completely over the lower seal spring.

d. Springs: Type 316 stainless steel.

e. Elastomers: Viton.

12. Moisture and Temperature Probes:

a. Provide two moisture detection probes to detect moisture in the seal and stator cavity ***or junction housing*** measuring conductivity ***or via a float sensor.***

b. Provide moisture detection panel and one piece cable from pump to panel, see electrical drawings for panel location. Contractor to provide conduit and cable from pump to control panel.

c. Provide sufficient length of cable to extend from the pump assembly to a junction box above top of wet well as stated in Part 6.

d. Provide O-ring sealed plugged fill and drain inspection ports.

e. Provide winding over temperature protection.

f. Moisture detection to alarm, over temperature to shut down pumps, indicate condition and alarm.

g. Provide NEMA 4X Type 316L stainless steel panel with moisture detection system.

13. Bearings:

a. Provide a minimum of two bearings permanently lubricated but capable of being regreased.

b. Minimum B-10 bearing life of 100,000 hours.

c. Provide RTD for thrust bearing.

14. Provide all mating surfaces machined and fitted with O-rings. All fittings shall be metal to metal contact between each machine surface.

15. Provide a Type 316 lifting attachment capable of lifting the entire pump and motor assembly.

16. Motors shall conform to UL or FM quality assurance specifications and be manufactured by an ISO-9001 company.

17. Provide a motor resistance monitor.

2.06 DISCHARGE BASE:

A. Provide an ASTM A48 Class 35 cast iron discharge base assembly including a 90 degree elbow and base to support the entire weight of the pump and motor and to secure the lower end of the guide rails.

B. Provide base machined to receive sliding bracket of pump discharge.

C. Provide seat constructed of bronze or non-metallic O-ring that is self-cleaning, non-clogging and non-sparking UL or RM certified explosionproof.

D. Bolt to floor with Type 316 stainless steel anchors.

2.07 GUIDE ASSEMBLY:

A. Provide Schedule 40 Type 316L stainless steel guide rails or Type 316 cables for each pump discharge assembly.

1. Guide Rail: Pump manufacturer's standard size but not less than 2-inch (50 mm) diameter.

B. Provide Type 316L stainless steel intermediate supports for guide rails with a maximum spacing of 10 feet between supports.

C. Provide Type 316L stainless steel top guide rail retainer brackets to support the guide rails or cables. Bracket to be attached to top slab of wet well.

D. Provide Type 316 stainless steel chain of sufficient length, to reach from pump to top of wet well plus 10 feet and of strength for lifting pump and motor. Provide chain designed for attachment to lifting bail provided on motor and to the guide rail retainer bracket.

2.08 PUMP LIFTING/DOCKING DEVICE

A. Provide a chain and latch mechanism to allow the pumps and motors to be removed in one pull without re-rigging the system. Provide a device that is lowered along the guide cables or rails and can be remotely latched to the pump lifting bail without the need to enter the wet well.

B. Materials:

1. Lifting Bail: ASTM A248 B

2. Hook, Shackle, Counterweight and Chain ***for each pump***: ASTM A322

3. Guide Ropes: Stainless Steel

4. Latch Operating Rope: Polyamid

C. Mechanism Lifting Capacity to be suitable for equipment provided.

D. Provide one (1) device for each size pump

2.09 HARDWARE:

A. Type 316 stainless steel.

2.10 GAUGES:

A. Provide gauges assemblies ~~for~~ as shown on the plans ***in*** accordance with Section 40 23 19.03 and as indicated.

B. Discharge Gauges: Compound type with operating range with top limit above pump shutoff head at maximum pump speed.

1. Scale: inches Hg to psi (mm Hg to kPa).

2.11 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10 Shop Painting and 09 96 00 High Performance Coatings.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.12 SHOP TESTING:

A. Comply with the requirements specified in Section 01 78 26 and as specified herein.

B. Provide motor shop testing in accordance with Section 40 23 13.03 and as specified.

1. Conduct motor efficiency and power factor tests at full load 100 and 50, 75 percent load.

2. Provide the following motor tests in accordance with ANSI/HI 11.6

a. Test motor integrity in a submerged condition.

b. Dry run no load test.

c. Motor electrical integrity test.

d. Moisture and temperature sensors integrity test.

C. Pump Tests:

1. Test pump casings under a hydrostatic head of at least 75 psi or 150 percent of rated shutoff head, whichever is greater. Test casing with pump assembled.

2. Provide certified performance tests as specified herein for all pumps and spare rotating assemblies except those specified to be witness tested.

3. Provide witness tests as specified herein for the pumps and for associated spare rotating assemblies:

4. Certified performance and witness testing.

   a. Testing of submersible pumps dry is not acceptable.

   b. Run pump at full speed rating point for 60 minutes prior to start of any testing.

   c. Full speed tests:

      (1) Test pumps at the conditions specified and indicated and take not less than seven operating points between shut-off and run out. Test points must be at the conditions specified and indicated.

      (2) Take readings to determine flow, differential pressure***, ~~rpm,~~*** horsepower, and wire to water efficiency.

      (3) Operate each pump for not less than one hour and take readings to determine that the pump will operate as specified and indicated without cavitation at the specified minimum head condition with not more than the specified NPSH available.

   d. Variable speed tests:

      (1) Conduct tests as specified above for full speed at reduced speeds except that tests for cavitation at run out are not required.

      (2) Run one speed test at speed required to discharge the minimum rating point specified and indicated with one point of test at the minimum rating point.

      (3) Run a second test at a speed approximately midway between full and minimum speed.

      (4) Run addition tests for each reduced speed operating condition specified and indicated.

   e. Conduct additional tests as follows:

      (1) Run each pump at the minimum speed rating point for 4 hours and continuously record motor temperature. Pumps must be run submerged at LWL submergence as indicated.

   f. Factory tests on pumps:

      (1) Use tested job motors and job variable frequency drives that are shipped to the pump testing facility for use in these pump tests.

      (2) Use factory calibrated test drives.

   g. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.

5. Run all tests in accordance with the latest standards of the Hydraulic Institute and as specified.

6. Testing Acceptance Grade and Tolerances:

   a. ANSI/HI 14.6 Acceptance Grade: 1U.

   b. Efficiency Tolerance: 0 percent.

   c. If pumps do not meet the tolerances specified, trim the impeller and retest until the specified results are obtained.

7. Tests of variable frequency motor controllers specified in Section 26 29 23.

8. In the event that specified tests indicate that pump, motor, or variable frequency drive will not meet specifications, Engineer has the right to require additional complete witnessed tests for all pumps, motors, and variable frequency drives at no additional cost to the Owner.

9. Repeat tests until specified results are obtained.

10. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

11. When pump witness performance testing is specified, provide roundtrip airfare, all transportation and lodging for witness testing for two (2) people. If air travel is more than 6 hours provide business class airfare.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with shop drawings, and manufacturer's printed instructions.

B. Install pumping units and align.

   1. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.

C. After alignment is correct, grout using high grade non-shrink grout.

   1. Do not imbed leveling nuts in grout.

3.02 FIELD TESTING:

A. Comply with the requirements specified in Section 01 75 13 and as specified herein.

B. Test piping connections to prove the pump nozzle are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles. This must be performed and the piping acceptable prior to any field performance testing.

C. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 01 for checklist.

D. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each pump in presence of theEngineer to determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.

1. During tests, observe and record head, capacity, and motor inputs.

    a. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.

2. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

3. Repeat tests until specified results are obtained.

4. Contractor to provide all water labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.

    a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all pumping systems even in those cases where permanent flow meters are installed.

    b. All calibrations must be within 30 days of the field testing.

    c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.

E. Make all adjustments necessary to place equipment in specified working order at time of above tests.

F. Test pump on product only. If product is not available, test with water. Water for testing furnished by Contractor.

G. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 43 21 00.23

PROCESS PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test process pumps, motors, variable frequency motor controllers, and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters.

B. ASTM International (ASTM):

1. A36/A36M: Standard Specification for Carbon Structural Steel.

2. A48/A48M: Standard Specification for Gray Iron Castings.

3. A108: Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished

4. B584: Standard Specification for Copper Alloy Sand Castings for General Applications

C. Hydraulic Institute (HI):

1. Current Standards.

2. 14.6: Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

D. National Electrical Manufacturers Association (NEMA):

1. MG1: Motors and Generators.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding pump and motor characteristics and performance:

a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, efficiency and NPSHr.

(1) For units of same size and type, provide curves for a single unit only.

b. Provide catalog performance curves at maximum pump speed indicated and specified for each service showing maximum and minimum impeller diameters available, acceptable operating range (AOR) and preferred operating range (POR).

c. Results of shop performance tests as specified.

d. Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch (A4) sheets, one curve per sheet.

2. Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide $NPSH_r$ curve for each speed.

3. Shop drawing data for accessory items.

4. Certified setting plans, with tolerances, for anchor bolts.

5. Manufacturer's literature as needed to supplement certified data.

6. Operating and maintenance instructions and parts lists.

7. Listing of reference installations as specified with contact names and telephone numbers.

8. Certified results of hydrostatic testing.

9. Certified results of dynamic balancing.

10. Bearing temperature operating range for the service conditions specified.

11. List of recommended spare parts other than those specified.

12. Shop and field inspection reports.

13. Bearing Life: Certified by the pump manufacturer. Include design data.

14. Pump shop test results.

15. Motor shop test results.

16. Qualifications of field service engineer.

17. Recommendations for short and long-term storage.

18. Resonant frequency analysis.

19. Shop and field testing procedures, pump and piping set up, equipment to be used and ANSI/HI testing tolerances to be followed.

20. Special tools.

21. Number of service person-days provided and per diem field service rate.

22. Results of field vibration test data including a vibration signature for each pump and drive assembly. Provide vibration testing procedure for review.

23. Recommended location of suction and discharge pressure gauges.

24. Manufacturer's product data, specifications and color charts for shop painting.

25. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

26. The latest ISO 9001 series certification.

27. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. For each pump:

    a. One complete set of gaskets and O-rings.

b. One mechanical seal repair kit and restriction brushing or spare mechanical seal for each pump provided with mechanical seals.

c. One shaft sleeve.

d. Also see additional spares listed in Specification 46 41 50.03: Hydraulic Mixing System and Appurtenances

2. For each set of pumps of the same size and performance.

a. One set of all special tools required.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Pumps of the same type shall be the product of one manufacturer.

C. Pumps shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.

E. Shop tests as specified.

F. The Contractor shall obtain the pumps, motors, couplings and appurtenances from the pump manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

1. Variable frequency motor controllers can be supplied by the Contractor or the pump manufacturer at the Contractor's option. The pumping system must be a complete and integrated package to insure proper coordination and compatibility and operation of the system.

a. The Contractor shall coordinate the variable frequency motor controllers with the pump and motor manufacturer and submit as part of the shop drawings a written statement signed by the Contractor, pump manufacturer, motor manufacturer and variable frequency motor controller manufacturer that the variable frequency motor controller manufacturer has received the required information from the pump and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also include all motor data and information that has been used for the coordination.

b. Provide variable frequency motor controllers in accordance with Section 26 29 23.

G. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.

H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:

   a. 1 person-days.

3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

   a. 2 person-days.

4. Performance Testing: Field performance test equipment specified.

   a. 2 person-days.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

   a. 2 person-days.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

I. Manufacturer of pumps shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

J. For variable speed pump systems the pump manufacturer must perform an analysis of the combined motor and pump assembly for resonant frequency or their harmonics independent of a structure.

1. Submit a copy of these calculations for the record.

2. Should calculations indicate the probability of encountering such frequencies within the speed range required, provide all additional supporting devices necessary to affect the unit mass, and raise or lower resonant point as necessary.

3. Provide and install such additional devices at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the Process Pump Schedule.

B. Pumps normally operate with a flooded suction except that pumps will be subject to a suction lift if indicated in the Process Pump Schedule.

2.02 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.03 PUMP CONSTRUCTION – GENERAL:

A. Pumps: Provide type, arrangement and drive as indicated in the Process Pump Schedule.

B. Design and proportion all parts of pump specially adapted for the service specified and indicated, i.e. the mixing of spent deicing fluid in the spent deicing fluid tanks as specified in Section 46 41 50.03.

C. Pump must be designed to withstand long periods (up to 6 months) of inoperation each year. Therefore bearings, seals, couplings, instrumentation and material selection will be purpose made for these conditions.

D. Belt driven pumps are not acceptable.

E. Pump Mounting:

1. Horizontal Pumps:

a. Mount each pump and drive on a common base.

(1) Material: ASTM A36/A36M fabricated structural steel.

(2) Provide structural steel shape bases for pumps 4-inch and larger and bent form bases for pumps smaller than 4-inch unless otherwise specified.

(3) Provide bases with provisions for grouting and for anchor bolts.

(4) Design baseplates and bases to support pump and driver.

(5) Provide planed surfaces of bearing pads for pumps and drives.

F. Design casings for removal of rotating parts without disconnecting suction and/or discharge piping.

G. Provide lifting devices on pump casings for handling.

H. Provide ribs or reinforcing required to withstand the specified hydrostatic test pressure, to prevent deflection caused by hydraulic thrust and to support the motor.

I. Provide components with machined registered concentric shoulder fits for precision alignment. Equipment without registered fits is not acceptable.

J. Seals:

1. Provide split mechanical seals for all direct coupled pumps unless otherwise specified

2. Split mechanical seal:

a. Manufacturer: Chesterton Style 442 or equal approved

b. Materials:

(1) Gland: Type 316 stainless steel.

(2) Rotary Holder: Type 316 stainless steel.

(3) Hardware: Type 316 stainless steel.

(4) Springs: Hastelloy C or Elgiloy.

(5) Rotating Faces: Silicon Carbide.

(6) Stationary Faces: Silicon Carbide.

(7) Elastomers: Viton.

(8) Restriction Bushing: Split type, glass filled teflon.

c. For pumps specified and indicated not requiring seal water, provide Enviroseal Spiraltrac bushing version D, type A.

(1) For vertically mounted pumps provide seal vent as indicated and in accordance with API Plan 13.

d. For pumps specified and indicated requiring seal water, provide seals with flushing water from a clean external source.

2.04 END SUCTION CENTRIFUGAL PUMPS:

A. Manufacturers:

1. Aurora

2. Goulds

3. Flowserve

4. Sulzer

5. Hayward Gordon

B. Type: Non-overloading, single stage volute centrifugal pumps. Directly coupled to motor.

1. End suction as indicated in the Process Pump Schedule.

2. Key seated, provide Type 316 stainless steel lock nuts.

C. Casing, Bearing Frame and Seal Plate: ASTM A48/A48M Class 30 cast iron.

D. Impeller: Type 316 stainless steel.

1. Enclosed, dynamically balanced.

E. Shaft: Steel ASTM A108-C1141.

F. Sleeves: Type 316 stainless steel.

G. Bearing: Grease lubricated ball bearings.

H. Mechanical Seals:

1. Provide as specified herein.

I. Motors: Provide as specified herein.

J. Couplings: Provide as specified herein.

K. Baseplates: Provide as specified herein.

2.05 MOTORS:

A. Provide in accordance with Section 26 20 00 and as specified and indicated.

B. Horsepower rating of motors: Not less than maximum brake horsepower requirements of pumps under any condition of operation specified and indicated without operating in the motor service factor.

C. Motor enclosure and motor speed: As indicated in the Process Pump Schedule.

D. Provide motors for flex-coupled pumps with base supports with machined registered joints for mounting on pump motor support.

E. Provide motors for horizontal pumps with mounts for bolting to baseplate.

F. In addition to the requirements for bearings specified under Electric Motors in Section 26 20 00, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum B-10 life of 100,000 hours.

G. Overall sound-pressure level of each motor shall not exceed 88 decibels when measured on flat network using an octave-band frequency analyzer conforming to ANSI S1.11. Determine overall

sound-pressure level as average of four or more readings at evenly spaced points, 3 feet (1 metre) from motor.

H. Operate without overheating at the speeds specified and indicated.

I. Service Factor: 1.15, with 1.0 inverter duty rating for pumps equipped with variable frequency motor controllers.

J. Premium efficiency with nominal and minimum efficiencies per NEMA MG1.

K. Rating: 460V, 3-phase, 60 Hertz.

L. Insulation: Class F with Class B temperature rise, 105 degrees F ambient.

M. Site Altitude: Less than 3,300 feet above sea level.

N. Provide Inpro/Seal bearing isolators.

2.06 COUPLINGS:

A. Non lubricated, polyurethane flex material type.

B. Split design.

C. Spacer type.

D. Manufacturer: Rexnord Omega or acceptable equivalent product.

E. Provide guards for protection for personnel, conforming to OSHA requirements.

F. Guards and Hardware: Type 316 stainless steel.

2.07 DRAIN, VENT AND SEAL WATER PIPING:

A. Provide drains from stuffing box and casing vent and drain piping and valves to discharge into gutters or sumps as indicated and as directed by the Engineer.

B. Provide seal water piping, valves and accessories at pump as specified and indicated.

C. Drain and vent piping: Schedule 10 Type 316L stainless steel with VicPress connections or Schedule 40 Type 316L stainless steel with socket welded connections. Provide a sufficient number of unions to permit removal of each valve and in-line device.

D. Seal water piping: Schedule 10 Type 316L stainless steel with VicPress connections or Schedule 40 Type 316L stainless steel with socket welded connections. Provide a sufficient number of unions to permit removal of each valve and in-line device.

E. Provide pipe and fittings in accordance with Section 40 23 19.04 and as indicated.

F. Valves: Provide size and type as indicated and in accordance with Section 40 23 13.01.

2.08 GAUGES:

A. Provide gauges assemblies for suction and discharge of each pump in accordance with Section 40 23 19.04 and as indicated.

B. Suction Gauges: compound type with operating range at approximately paint of the gauge range.

1. Scale: inches Hg to psi

C. Discharge gauges: Provide standard range with top limit above pump shutoff head at maximum pump speed.

1. Scale: psi

2.09 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 1009940 Shop Painting and Section 09 96 00 High Performance Coatings.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.10 SHOP TESTING:

A. Provide motor shop testing in accordance with Section 26 20 00.

B. Pump Tests:

1. Test pump casings under a hydrostatic head of at least 75 psi or 150 percent of rated shutoff head, whichever is greater.

2. Provide certified performance tests as specified herein for all pumps

3. Certified performance testing.

a. Run pump at full speed rating point for 60 minutes prior to start of any testing.

b. Full speed tests:

(1) Test pumps at the conditions specified and indicated and take not less than seven operating points between shut-off and run out. Test points must be at the conditions specified and indicated.

(2) Take readings to determine flow, differential pressure, rpm, horsepower, and efficiency.

(3) Operate each pump for not less than one hour and take readings to determine that the pump will operate as specified and indicated without cavitation at the

specified minimum head condition with not more than the specified NPSH available. Test with the job submergence as indicated.

c. Variable speed tests:

(1) Conduct tests as specified above for full speed at reduced speeds except that tests for cavitation at run out are not required.

(2) Run one speed test at speed required to discharge the minimum rating point specified and indicated with one point of test at the minimum rating point.

(3) Run a second test at a speed approximately midway between full and minimum speed.

(4) Run addition tests for each reduced speed operating condition specified and indicated.

d. Factory tests on pumps:

(1) Use tested job motors that are shipped to the pump testing facility for use in the pump tests.

(2) Use factory test motors.

(3) Use factory calibrated test drives.

e. Provide a minimum of 30 days written notice to the Engineer prior to shop testing.

4. Run all tests in accordance with the latest standards of the Hydraulic Institute and as specified.

5. Testing Acceptance Grade and Tolerances:

a. ANSI/HI 14.6 Acceptance Grade: 1U.

b. Efficiency Tolerance: -0 percent.

c. If pumps do not meet the tolerances specified, trim the impeller and retest until the specified results are obtained.

6. Tests of variable frequency motor controllers specified in Section 26 29 23.

7. In the event that specified tests indicate that pump, motor, or variable frequency drive will not meet specifications, Engineer has the right to require additional complete tests for all pumps, motors, and variable frequency drives at no additional cost to the Owner.

8. Repeat tests until specified results are obtained.

9. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.

B. Install pumping units on a concrete pad and align thereon.

1. Coupling halves must be disconnected and only reconnected after alignment.

2. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.

C. Horizontal pumps: Dowel pump and drive to baseplate after alignment in field to facilitate realignment after disassembly.

D. Final Coupling Alignment:

1. Perform only after base is installed and piping is connected and pump nozzle connections tested in accordance with paragraph 3.02.

2. If realignment is required piping must be disconnected prior to alignment, piping reconnected and alignment checked prior to connecting coupling halves.

E. After alignment is correct, grout using high grade non-shrink grout.

1. For horizontal pumps fill entire base and leave no gaps or voids.

2. Do not imbed leveling nuts in grout.

3.02 FIELD TESTING:

A. Comply with the requirements specified in Section 01 78 25 and as specified herein.

B. Test piping connections to prove the pump nozzle are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles. This must be performed and the piping acceptable prior to any field performance testing.

C. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 01 for checklist.

D. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer’s field service technician, conduct running test for each pump in presence of the Engineer to determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.

1. During tests, observe and record head, capacity, pump bearing housings and motor bearing temperature, noise and vibration and motor inputs.

a. Provide vibration signature test data for each pump and drive assembly.

(1) Limit: 50 percent of ANSI/HI allowable limits.

b. Bearing Temperature: Bearing temperature not to exceed 180 degrees F.

c. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.

2. Run each pump for minimum four hours prior to taking temperature readings of the pumps, motors, and shafting.

3. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

4. Repeat tests until specified results are obtained.

5. Contractor to provide all water labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.

a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all pumping systems even in those cases where permanent flow meters are installed.

b. All calibrations must be within 30 days of the field testing.

c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.

d. Contractor is responsible for delivery and disposal of water used for testing.

E. Make all adjustments necessary to place equipment in specified working order at time of above tests.

F. Test pump on product only. If product is not available, test with water. Water for testing furnished by Contractor.

G. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 43 21 00.23

SECTION 44 42 46.01

STATIC MIXERS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide static mixers and appurtenances as indicated and in compliance with Contract Documents.

1.02 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding static mixers characteristics and performance:

a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of duplicate mixers, showing they meet indicated and specified requirements for capacity, and pressure drop.

b. Curve of flow vs pressure drop

c. Results of shop performance tests as specified.

d. Submit curves for guaranteed performance, and shop performance tests on 8-1/2-inch by 11-inch (A4) sheets, one curve per sheet.

2. Shop drawing data for accessory items.

3. Manufacturer's literature as needed to supplement certified data.

4. Operating and maintenance instructions and parts lists.

5. Listing of reference installations as specified with contact names and telephone numbers.

6. Certified results of hydrostatic testing.

7. Shop and field inspection reports.

8. Qualifications of field service engineer.

9. Recommendations for short and long-term storage.

10. Special tools.

11. Number of service person-days provided and per diem field service rate.

12. Recommended location of pressure gauges.

13. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

14. The latest ISO 9001 series certification.

15. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.03 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

1. One set of all special tools required.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Static mixers shall be the product of one manufacturer.

C. Static mixers shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Shop tests as specified.

E. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.

F. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping:

a. 0.25 person-days.

3. Performance Testing: Field performance test equipment specified.

a. 2 person-days.

4. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

a. 1 person-days.

5. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

6. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

G. Manufacturer of static mixers shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

H. If equipment proposed is larger than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Static mixer capacities and operating data are indicated in the Static Mixer Schedule.

2.02 MANUFACTURERS:

A. Static Mixers:

1. Sulzer Chemtech.

2. Westfall.

3. Mixtec

2.03 STATIC MIXER CONSTRUCTION:

A. Provide the mixer consisting of a ring incorporating a mixing element and integrated dosing points.

B. Provide the mixer with two mixing vanes and additional vanes for injecting each chemical specified into the main flow stream.

C. Provide the mixer installed in the piping, mounted between two flanges.

D. Provide the mixer with an open structure guaranteeing reliable operation without the danger of clogging.

E. The mixing vanes and additive vane arrangement must provide an efficient mixing action regardless of additive to water mixing ratio.

F. Mixer housing maximum design temperature: 150 degrees F.

G. Materials:

1. Housing: Type 316 Stainless Steel, epoxy lined and coated

2. Elements: Type 316 Stainless Steel, epoxy lined

3. Hardware: Type 316 stainless steel.

H. Chemical Injection:

1. Provide 150-lb (PN10) flat faced flanged connection ports for the injection of each additive to the main stream.

2. Provide the number and size as specified and indicated.

2.04 GAUGES:

A. Provide gauges assemblies upstream and downstream of each static mixer.

B. Provide assemblies as specified in Section 40 23 19.05 and as indicated.

C. Gauge Range: 0 to 15 psi.

D. Mixer manufacturer to provide recommended locations for gauges, the gauge location will be used for the field testing as specified herein.

2.05 STATIC MIXER SCHEDULE:

Tag Number	SD-SM-01, 02
Number of Mixers	2
Body Type	Wafer/helical
Mixer Housing Design Pressure, psi	TBD by Contractor
Minimum Flow Rate, mgd	TBD by Contractor
Maximum Flow Rate, mgd	TBD by Contractor
Sodium Hydroxide (50 percent) at Min flow (min/ave/max), gph	0.02/13.7/27.3
Sodium Hydroxide (50 percent) at Max flow (min/ave/max), gph	40.2/117.2/234.4
Coefficient of Variation (σ/x), Maximum, at 3 diameters downstream of mixer outlet	0.05
Number of Injection Ports	2
Injection Port Diameter, in	1/2
Line Size, inches	TBD by Contractor
Static Mixer Size, inches	TBD by Contractor
Maximum Laying Length, inches	30
Mounting Flanges	TBD by Contractor

A. Provide the mixer to mix the chemicals specified into the water such that the maximum deviation of concentration will be +/- 5 percent of the average or target concentration.

2.06 SHOP TESTING:

A. Provide certified performance test data confirming the uniformity and pressure drop.

1. If data is not available conduct shop testing

B. In the event that specified tests indicate that the static mixer will not meet the specified requirements repeat tests until specified results are obtained

C. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.

3.02 FIELD TESTING:

A. Test piping connections to prove the chemical function nozzles are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with static mixer connections nozzles. This must be performed and the piping acceptable prior to any field performance testing.

B. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 1 for checklist.

C. After installation of static mixers, and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct running test for each static mixer in presence of the Engineer to determine its ability to operate within the vibration and temperature limits specified, and to deliver its rated capacity under specified conditions.

1. During tests, observe and record, capacity and pressure drop.

2. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

3. Repeat tests until specified results are obtained.

4. Contractor to provide all water labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.

a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters.

b. All calibrations must be within 30 days of the field testing.

c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.

D. Make all adjustments necessary to place equipment in specified working order at time of above tests.

E. Test on product only. If product is not available, test with water. Water for testing furnished by Contractor.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 44 42 46.01

SECTION 44 43 33.10

INTAKE SCREENS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test intake screens, air burst system, controls and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. S1.11: Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets.

B. American Society of Mechanical Engineers (ASME):

1. Section IX: Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators - Non-Interfiled.

C. American Water Works Association (AWWA):

1. C207: Steel Pipe Flanges for Waterworks Service Sizes 4 Inch. Through 144 Inch (100 mm Through 3,600 mm).

D. National Electrical Manufacturers Association (NEMA):

1. MG1: Motors and Generators.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Certified shop and erection drawings. Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified.

2. Data regarding equipment performance and motor characteristics and performance:

a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop tests of mechanically duplicate equipment, or hydraulic lab testing showing they meet indicated and specified requirements for flow capacity and pressure drop.

(1) For units of same size and type, provide curves for a single unit only.

b. Results of shop performance tests as specified.

c. Submit curves for guaranteed performance on 8-1/2-inch by 11-inch (A4) sheets, one curve per sheet.

3. Drawings showing screen diameter length, outlet size and slot opening, materials of construction and assembly weight.

4. Hydraulic calculations verifying compliance to the design criteria.

5. Strength calculation verifying compliance to the specified criteria.

6. Shop drawing data for accessory items.

7. Certified setting plans, with tolerances, for anchor bolts.

8. Manufacturer's literature as needed to supplement certified data.

9. Operating and maintenance instructions and parts lists.

10. Listing of reference installations as specified with contact names and telephone numbers.

11. Certified results of hydrostatic testing.

12. Bearing temperature operating range for the service conditions specified.

13. List of recommended spare parts other than those specified.

14. Shop and field inspection reports.

15. Bearing Life: Certified by the equipment manufacturer. Include design data.

16. Equipment shop test results.

17. Motor shop test results.

18. Qualifications of field service engineer.

19. Recommendations for short and long-term storage.

20. Shop and field testing procedures, set up and equipment to be used.

21. Special tools.

22. Number of service person-days provided and per diem field service rate.

23. Manufacturer’s product data, specifications and color charts for shop painting.

24. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

25. The latest ISO 9001 series certification.

26. Provide a scaled drawing showing the equipment, motors, hoists and bridge cranes including equipment weights, lifting attachments, slings and clearances for equipment removal and maintenance.

27. Material Certification:

a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. One complete set of gaskets and O-rings.

2. One set of all special tools required.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Equipment specified shall be the product of one manufacturer.

C. Equipment specified shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.

E. Shop tests as specified.

F. Provide receivers fabricated by ASME Section IX Certified welders. The manufacturer shall provide evidence of experience in having supplied at least five assemblies of similar designs which have been in successful service for at least five (5) years.

G. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.

H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:

    a. 0.2 person-days.

3. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

    a. 0.2 person-days.

4. Performance Testing: Field performance test equipment specified.

    a. 0.2 person-days.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

    a. 0 person-days.

6. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

7. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

I. Manufacturer of specified equipment shall have a minimum of five (5) operating installations with equipment of the size specified and in the same service as specified operating for not less than five (5) years.

J. If equipment proposed is heavier or taller, different width or length than specified and indicated; provide all structural and mechanical revisions at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Screening system capacities and operating data are indicated in the Intake Screen Schedule.

2.02 MANUFACTURERS:

A. Hendrick Screen Company

B. Johnson Screens

C. Norris Screen

D. Elgin Separation Solutions

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 SCREEN CONSTRUCTION:

A. Intake Screens:

1. Provide screens manufactured by an ISO 9001 Certified company.

2. Provide screens fabricated by ASME Section IX Certified welders, manufacture shall provide evidence of experience in having supplied at least five assemblies of similar designs which have been in successful service for at least three years.

3. Intake Screen: Cylindrical with circumferential slots that widen toward the inside of the cylinder.

4. Screen surface wire: Wedge Wire cross-wire welded to a support member to provide necessary strength with minimal hydraulic resistance.

5. Provide screens with an internal flow collector pipe designed to ensure a uniform flow distribution through the screen slots during water intake.

6. Provide screen equipped with a truncated cone debris deflector on each end.

7. Design stress: Maximum of two thirds of the yield stress.

8. Wire and Supports: Type 316L stainless steel.

9. Body, Flanges and Hardware: Type 316 stainless steel.

10. Outlet Connection: Flanged with a bolt pattern equal to AWWA C-207, Table 1, Class B.

11. Airburst cleaning connection: Flanged ANSI Class 150 (PN10) raised face slip on flange.

B. Intake Screen Schedule:

Service Conditions	Filtered Secondary Wastewater Effluent
Number of Screens	2
Number of Operating Screens	1
Intake Screen Design Capacity, gpm	8,550
Safety Factor, percent	20
Total Screen Design Capacity, gpm	10,260
Screen Configuration	Tee
Slot Width, in	0.125
Open Area, percent	64
Wire Width	0.069
Maximum Slot Velocity, fps	0.50
Pressure Drop, Clean Screen, psi	0.10
Total pressure drop through the Tee assembly, feet	1.0
Maximum Screen Length, in	26
Design Hydrostatic Pressure, feet to centerline of screen	30
Screen Outlet Connection, in	36
Airburst Cleaning Connection, in	3

C. Design and proportion all parts of screens specially adapted for the service specified and indicated.

2.05 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy in accordance with Section 09 91 10.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

2.06 SHOP TESTING:

A. Provide motor shop testing in accordance with Section 26 20 00.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.

B. After alignment is correct, grout using high grade non-shrink grout.

1. Do not imbed leveling nuts in grout.

3.02 FIELD TESTING:

A. Comply with the requirements specified in Section 01 78 25 and as specified herein.

B. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 1 for checklist.

C. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by the manufacturer’s field service technician, conduct running test for each unit in presence of the Engineer to determine its ability to deliver its rated capacity under specified conditions.

1. During tests, observe and record pressures, capacity, recharge time, motor bearing temperature, noise and vibration and motor inputs.

a. Test Duration: Determined by the Engineer, but not less than three cycles.

2. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

3. Repeat tests until specified results are obtained.

D. Make all adjustments necessary to place equipment in specified working order at time of above tests.

E. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00

END OF SECTION 44 43 33.10

SECTION 46 33 42

CHEMICAL DIAPHRAGM METERING PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test chemical diaphragm metering pumps and appurtenances, as indicated and in compliance with Contract Documents.

B. Provide each chemical pumping system complete. And before acceptance make each system fully operational and ready for use by the Owner.

C. Chemical for testing to be supplied by the Owner.

D. Basic laboratory equipment for initial dosage testing to be supplied by the Contractor.

1.02 REFERENCES:

A. National Electrical Manufacturers Association (NEMA):

1. ICS 1: Industrial Control and Systems General Requirements

B. International Organization for Standardization (ISO):

1. 9001: Quality Management Systems - Requirements

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. When the Contractor proposes equipment, which requires an arrangement differing from that indicated on the drawings or specified, prepare and submit for review detailed structural, mechanical, and electrical drawings and equipment lists, utilities consumption schedule and operating instructions, showing necessary changes and embodying special features of the equipment he proposes to furnish. Make changes, if accepted at no additional cost to Owner.

2. Submit certified shop drawings, manufacturer's specifications, catalog data, descriptive literature, illustrations, and other materials necessary for proper appraisal of quality and function.

3. Include factory work sheets which identify each piece of equipment as specified herein and on drawings.

4. Sales bulletins or other general publications are not acceptable as submittals for review except where necessary to provide supplemental technical data.

5. Number and identify equipment to correspond with terminology on drawings. Use these numbers on all submittal sheets and shop drawings.

6. Furnish for each system piping schematic and wiring schematic with interconnection diagram and a complete description of operation.

7. Pump Control Panel:

   a. Front elevations, with and without door.

   b. Elementary wiring connection diagram.

   c. Catalog sheets for devices in the control panel.

   d. Use NEMA device designations and symbols for electric diagrams. Make contents of elementary connection diagrams in accordance with NEMA ICS 1.

   e. Manufacturer's standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.

8. Vendor to confirm with calculations that the pumps offered can handle the piping as shown.

9. Operating and maintenance instructions and parts lists.

10. Templates or certified setting plans, with tolerances, for anchor bolts.

11. Equipment specified to have variable-frequency drives: Submit wiring diagrams with instructions for bypassing the speed controller in the event of its failure, to allow running the drive motor directly on AC line current.

12. Variable-frequency drive (VFD), see Section 26 29 23.

13. Recommended spare parts other than those specified.

14. Recommendations for short and long term storage.

15. Submit recommended charging pressures for pulsation dampeners.

16. Submit accuracy and readability limits for pump stroke position indicators and speed indicators.

17. Manufacturer's product data and specifications for shop painting.

18. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

19. The latest ISO 9000 series certification or certified quality assurance/control program document.

20. Provide qualifications of service/start-up personnel.

21. Material Certification:

a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Based on incompatibility with the service conditions, provide technical data and provide proposed materials.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

22. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required.”

a. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

23. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

b. Failure to include a copy of the marked up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. General:

1. Do the work required by and in accordance with applicable State and local codes; arrange for all permits, inspections and tests required by these codes. Provide systems and items of equipment that conform to applicable safety standards including those for safety of personnel.

2. One vendor to provide equipment and appurtenances, regardless of manufacturer, and is responsible for the satisfactory operation of the systems. Substitutions on functions specified are not acceptable.

3. Provide components to manufacturer's standard for service intended unless otherwise required.

4. Pumps of the same type to be the product of one manufacturer. Provide equipment of manufacturers' latest and proven design. Pumps to be standard cataloged products.

5. Drawings and specifications direct attention to certain required features of the equipment, but do not purport to cover all details entering into its design, construction and installation; nevertheless, furnish and install equipment so that systems will be complete and ready for operation.

C. Service:

1. Services of Manufacturer's Representative stated in Section 01 43 00 and as specified herein.

2. Provide services of factory-trained Service Personnel, specifically trained on type of equipment specified.

a. Submit qualifications of Service Engineer for review.

b. Person-day requirements listed exclusive of travel time, and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.

c. Installation: Sufficient time to assist in location of anchor bolts; setting, leveling, alignment, field erection, etc.; coordination of piping, electrical, miscellaneous utility connections, but not less than:

(1) 1 person-days.

d. Start-Up: Sufficient time for calibration, testing and start-up, but not less than:

(1) 1 person-days.

e. Performance Testing: Time for field acceptance testing, but not less than:

(1) 1 person-days.

f. Instruction: Sufficient time for classroom and/or field operation and maintenance instruction, but not less than:

(1) 1 person-days.

g. Credit to the Owner unused service person-days specified above at the manufacturer's published field service rate plus any costs of travel.

3. The minimum days specified above does not relieve the manufacturer of responsibility of providing sufficient service to place components and systems in satisfactory operation. Provide, in addition to time periods specified above, time and material used to correct defective equipment at no additional cost to Owner.

4. 8-hour days specified are exclusive of travel time.

5. Turn on no form of energy to any part of systems prior to receipt by Engineer of certified statement of approval of installation from Contractor containing his supplier's authorization

to energize system unless done by the supplier's servicemen may do so for purposes of checkout.

6. The Manufacturer's Representative must maintain a factory trained serviceman with parts within 150 miles of this Owner.

D. Pumps, Motors and Controllers:

1. Pump manufacturer shall furnish the pumps, motors and variable frequency drives, if required, regardless of manufacturer, as a complete package to ensure proper coordination and compatibility of equipment. Refer to Section 26 29 23.

2. Prior to shipment to job site, pump manufacturer must perform a test on the combined motor and pump assembly.

1.05 SPARE PARTS:

A. Furnish following spare parts, identical and interchangeable with similar parts installed in work:

1. For each chemical metering pump:

a. One replacement for each diaphragm.

b. Two ball checks assemblies.

c. Two seats.

d. Five sets of check valve O-rings/gaskets.

e. Two complete sets of gaskets.

f. One assembly tool for pump diaphragm if required.

2. One of each type and material back pressure regulator with one spare diaphragm and spring for each.

3. One spare diaphragm and air valve for each discharge pulsation dampener.

4. One complete spare VFD control package for each type installed, including power supply, signal isolation/interface, and controls.

5. Provide all other manufacturer's recommended spare parts necessary to maintain each piece of equipment for a period of one year.

B. Spare laboratory equipment for dosage testing

1. Four 250 mL glass beaker

2. pH meter, Extech PH220-C Waterproof Palm pH Meter W/Temperature, Electrode W/ Cable.

3. Grab sampling tool, mounted on suitable wall brackets inside the mixing/dosing building, Cole-Parmer® Disposable Polyethylene, PVC Bailers and Wildco 62-C15 Polyester Line.

C. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which they are intended.

D. Deliver spare parts at same time as equipment to which they pertain. Properly store and safeguard such spare parts until completion of work, and then deliver to Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the Pump Schedule.

B. General

1. The system shall consist of one 260 Gal. tote for the required caustic soda. The tote shall sit on containment pallets to avoid spills.

2. Caustic soda shall be supplied in the concentration required, without need for dilution. Exact chemicals to be used shall be determined after a filed jar test by the chemical supplier.

3. Metering pumps shall be mounted on shelves adjacent to the tote as indicated in the contact diagram.

4. The metering pumps shall feed into the mixing pumps discharge lines.

5. The tote shall be covered by a heater blanket to keep its temperature above caustic soda freezing point.

2.02 CHEMICAL SYSTEM COMPONENTS:

A. Provide systems constructed of components which are compatible and suitable for intended service.

B. Chemical feed system to consist of pumps, mixers, and appurtenances, as indicated and specified.

C. Provide prewired system for electrically operated and motor-driven equipment including all auxiliary relays so as to require only power and external connections.

2.03 PUMP CONTROL PANELS:

A. Provide factory wired panels in accordance and with the following:

1. Panels to be fabricated in accordance with Section 40 90 00.

2. NEMA Type 4X enclosures of fiberglass reinforced polyester, gasketed to prevent chemical corrosion. Aluminum NOT ACCEPTABLE. Provide electrical control items that are rated NEMA Type 4, unless otherwise specified.

3. Variable speed pumps with variable frequency drive as specified under Section 26 29 23 and as indicated in the chemical pump schedule on the drawings.

4. Instruments and accessories to be as specified in Section 40 90 00.

5. Accessories mounted and wired to terminal strips or bulkhead fittings and properly identified to provide ease of field connection.

6. Controls for electrically operated or motor-driven equipment, with appurtenances, to require only terminal wiring and connections to equipment.

7. Control contacts rated not less than 10 amperes on 120 volts and gold plated contacts for low current instrument signals.

8. Lamicoid nameplates with filled engraved legends.

B. Pump Control/Drive:

1. Maximum allowable motor speed for motors is 1,800 rpm. Provide motors and wiring as specified hereinbefore and under appropriate electrical sections.

2. Pump drive to have a totally-enclosed fan-cooled constant speed alternating current motor. Provide local STOP-START-LOCKOUT switches for control of such pumps.

3. Remote controls, where indicated, but not specified herein, are specified in Section 40 90 00.

4. Power shall be as indicated on the project documents.

2.04 PUMPING EQUIPMENT:

A. Electronically Actuated Metering Pumps:

1. Acceptable Manufacturers:

a. Liquid Metronics Division, Milton Roy.

b. Pro Minent Fluid Controls.

c. Pulsafeeder.

d. Aldos.

e. Wallace & Tiernan.

2. Provide metering pumps of the electronic solenoid operated type and of positive displacement with no mechanical linkage. Adjust output volume while pumps are in operation. Power supply will be 115 volt, 60 Hertz.

3. Provide pump that is able to store and display the current flowrate and the cumulative flowrate (totalizer) in user-specified units.

4. Provide pump with onboard flow adjustment of ± 1% accuracy.

5. Provide pressure limited pumps that when the back pressure exceeds the magnetic force of the power coil, the pump shall stop, and no damage will occur.

6. Provide totally enclosed pumps for corrosion protection with housings and covers resistant to the atmosphere involved. Provide modular component and major assemblies to allow easy replacement without soldering.

7. Provide metering head of flat diaphragm operated and with check valves of materials resistant to the chemicals stated. Provide compatible connections with the piping indicated.

8. Provide pump with wide rangeability of up to 200 to 1, with adjustment of both stroke length and stroke frequency. Adjustments shall be accessible on the metering pump. An on-off power switch shall be indicated.

9. Provide automatic control with an input signal from INSTRUMENTATION. To furnish a signal compatible with the metering pump a converter may be required, if so, it shall be provided complete. It shall have an automatic-manual, span, zero and on-off switches.

10. Accessories:

    a. Provide wall bracket to support the metering pump. Allow access to the controls and liquid ends.

    b. Provide 65 feet of stainless steel 316 tubing (including all fittings and pipe supports) with SS 316 ball valves after the pump and before the static mixer's inlet.

    c. Provide a pipe for suction tubing straightening.

    d. Provide a foot valve and all other valves as per drawing.

    e. Provide a calibration column.

    f. Provide wall-mounted and pipe support bench manufactured from polypropylene.

2.05 METERING PUMP APPURTENANCES:

A. Back Pressure Valves:

1. Provide back pressure regulating valves where indicated on drawings. Provide back pressure regulators of polyvinylchloride or CPVC construction, and having Hypalon or Teflon diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Provide spring opposed diaphragms with loading pressures adjustable by means of screw in top works. Field-adjust valves to settings required of the system. Setting to be minimum pressure to occur upstream of the valve, as installed in system, while pump is operating.

2. Provide materials of construction compatible with the service specified and indicated.

B. Multifunction Valves:

1. Provide four or five function valves as shown. Four function valves shall include a back pressure regulator, drain, vent and prime functions. The five function valve shall include those plus an air release. Provide valve of polyvinylchloride or CPVC construction, and having Hypalon or Teflon diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Field-adjust valves to settings required of the system. Setting to be minimum pressure to occur upstream of the valve, as installed in system, while pump is operating.

C. Pulsation Dampeners:

1. Provide discharge pulsation dampeners on metering pumps where indicated suitably size for displacement of each pump to limit discharge pressure to plus/minus 10 percent. Provide pulsation dampeners of type which has a diaphragm separating air chamber from liquid chamber. Provide diaphragm of molded construction and that prevents air charge from being dissolved in process fluid. Provide lower chamber of Type 316 stainless steel lined, or of inert plastic material to prevent corrosion by process fluid. Provide materials suitable for intended service. Charge air chamber with compressed air to pump manufacturer's recommended charging pressure. Equip upper chamber with tire valve type of charging valve and air pressure gage with shutoff valve.

2. Provide a bicycle pump with handle and sufficient capacity to charge the pulsation dampeners. Bicycle pump to be easy to handle.

3. Furnish an airline and air hose with pressure regulator and hand-operated, lever-type valve, suitable for charging pulsation dampeners. Provide air hose long enough to reach pulsation dampeners.

D. Pressure Relief Valves:

1. Provide pressure valves where indicated on drawings. Provide pressure relief of polyvinylchloride or CPVC construction, and having Hypalon or Teflon diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Provide spring opposed diaphragms with loading pressures adjustable by means of screw in top works. Field-adjust valves to settings required of the system. Setting to be the maximum pressure to occur downstream of the valve, as installed in system, while pump is operating.

E. Calibration Standpipes:

1. Equip each group of pumps indicated on drawings with calibration standpipe for measuring pump output.

2. Provide standpipes of Schedule 40 clear PVC pipe with Schedule 80 fittings. Thin wall tubing and acrylic plastics not acceptable.

3. Equip each standpipe with flanged connection to suction piping, and fitted with ball valve for air venting, as indicated on drawing. Provide fittings of socket weld type. Provide valves and fittings as specified under other sections referenced.

4. Provide one calibration standpipe for each group of pumps indicated, of the height indicated on the drawing, and of a diameter such that the measurable capacity of the standpipe is approximately one and one-half minutes discharge of each pump at maximum pumping

capacity. Length of the standpipe indicated is the length of clear observable pipe and does not include length of fittings or connections. Permanently calibrate each standpipe in gallons and tenths.

5. Provide valves and flanges at each pump suction for attachment of calibration standpipes. Install pump suction and discharge piping so as not to interfere with location and use of standpipes.

2.06 SHOP PAINTING:

A. Provide as specified in Section 09 91 10, Shop Painting and 09 96 00 High Performance Coatings for pump casings.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install equipment and appurtenances in accordance with manufacturers printed instructions, as indicated and specified.

B. Install chemical processing units as shown on the drawings. Assure there is no pipe stress on piping connections and grout base.

3.02 FIELD CALIBRATION AND TESTING:

A. General:

1. Coordinate testing with operation of other portions of the facility, as required. Arrange for temporary piping and wiring modifications which may be needed if chemical cannot be fed at intended dosing points, or if other interconnected electrical equipment is not operational.

2. Calibrate in the presence of the Engineer.

3. After cleaning, completely test chemical feed system to verify that equipment is capable of performing its specified function in satisfactory manner without mechanical or electrical defects, binding, or operational difficulties. Correct defects and deficiencies and repeat all tests until satisfactory results are obtained. Correct excessive vibration leakage or noise. Make connections watertight or dusttight.

4. Demonstrate accuracy of units and bring within limits specified herein.

5. At the time of the tests, make final adjustments necessary to place equipment in satisfactory working order.

6. Test and calibrate equipment and accessories specified herein in accordance with manufacturer's printed instructions over full operating range of equipment.

7. Water testing is permitted where appropriate for preliminary testing purposes; however, conduct acceptance tests using appropriate chemicals for which each system was designed.

8. Complete preliminary and calibration testing and corrections prior to acceptance testing, as specified herein, to be conducted with the manufacturer's technical representative.

9. Copies of tests to be furnished to the Engineer.

10. Neutralize and dilute chemicals wasted during testing procedures with 10 volumes of water prior to disposal into plant drain system. Direct dumping into drains without prior neutralization and dilution is hazardous and not permitted.

11. Identify any exceptions to specification in documentation.

B. Chemical Pumps (Acceptance Tests):

1. Submit five copies of manufacturer's preliminary and calibration pump curves showing numerical values of pump discharge to nearest tenth of a gallon per hour, at 100, 75, 50, and 25 percent stroke settings.

2. Perform testing at 100, 75, 50 and 25 percent of speed settings.

3. Submit five copies of individual pump calibration curves to Engineer at least 15 days prior to acceptance testing. Notify Engineer in writing when pumps are ready for acceptance testing and make no adjustments or modifications to pumps after that time, without written permission of Engineer.

4. During acceptance testing demonstrate correct functioning of control stations.

5. Perform testing in the following manner:

   a. Test pumps by filling calibration standpipe with chemical and measuring time to pump a given volume out of the standpipe, with all other equipment valved off. Make test measurements of at least fifty seconds duration, using two stopwatches reading time to nearest one-hundredth second. Discard measured times differing more than one-half second. Average times differing by one-half second or less. Record averaged time for use in determining acceptability of pumps.

   b. For pumps equipped with back pressure valves, perform testing at the back pressure valve setting of 50 psig.

6. To determine deviation, compare measured pump output at various settings with output indicated by manufacturer's calibration curves. Pumps with deviation greater than plus or minus 3.0 percent of maximum pump output are not acceptable. Add one percent to allowed tolerances specified herein for pumps having variable speed drives.

7. Demonstrate pumps are capable of pumping zero flow at zero percent stroke, 100 percent speed settings. Pumps unable to meet this requirement are not acceptable.

8. If pump output varies excessively, it is possible the pump is air bound. Operate pump for five minutes at back pressure valve setting of 50 psig. Pumps unable to relieve themselves of air within five-minute period are not acceptable.

9. Operate pumps for period of four hours to demonstrate satisfactory operation.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 46 33 42

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SECTION 46 33 44

CHEMICAL PERISTALTIC METERING PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test peristaltic metering pumps and appurtenances, as indicated and in compliance with Contract Documents.

B. Pump will be used to pump spent deicing fluid from the Spent Deicing Meter Box to the Total Organic Carbon (TOC) analyzer inside the Mixing-Dosing building.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A48: Standard Specification for Gray Iron Castings

3. A322: Standard Specification for Steel Bars, Alloy, Standard Grades

4. A570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality

B. National Electrical Manufacturers Association (NEMA):

1. ICS 1: Industrial Control and Systems General Requirements

2. MG1: Motors and Generators

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Prior to initial submittal, arrange conference in Engineer's office with Engineering Representatives of equipment vendor who are familiar with specification to discuss overall job concept.

2. When the Contractor proposes equipment which requires an arrangement differing from that indicated on the drawings or specified, prepare and submit for review detailed structural, mechanical, and electrical drawings and equipment lists, utilities consumption schedule and operating instructions, showing necessary changes and embodying special features of the equipment he proposes to furnish. Make changes, if accepted at no additional cost to Owner.

3. Submit certified shop drawings, manufacturer's specifications, catalog data, descriptive literature, illustrations, and other materials necessary for proper appraisal of quality and function.

4. Include factory work sheets which identify each piece of equipment as specified herein and on drawings.

5. Sales bulletins or other general publications are not acceptable as submittals for review except where necessary to provide supplemental technical data.

6. Number and identify equipment to correspond with terminology on drawings. Use these numbers on all submittal sheets and shop drawings.

7. Furnish for each system piping schematic and wiring schematic with interconnection diagram and a complete description of operation.

8. Pump Control Panel:

    a. Front elevations, with and without door.

    b. Elementary wiring connection diagram.

    c. Catalog sheets for devices in the control panel.

    d. Use NEMA device designations and symbols for electric diagrams. Make contents of elementary connection diagrams in accordance with NEMA ICS 1.

    e. Manufacturer's standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.

9. Vendor to confirm with calculations that the pumps offered can handle the piping as shown.

10. Operating and maintenance instructions and parts lists.

11. Templates or certified setting plans, with tolerances, for anchor bolts.

12. Equipment specified to have variable-frequency drives: Submit wiring diagrams with instructions for bypassing the speed controller in the event of its failure, to allow running the drive motor directly on AC line current.

13. Recommended spare parts other than those specified.

14. Recommendations for short and long term storage.

15. Submit recommended charging pressures for pulsation dampeners.

16. Submit accuracy and readability limits for pump speed indicators.

17. Manufacturer's product data and specifications for shop painting.

18. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

19. The latest ISO 9000 series certification or certified quality assurance/control program document.

20. Provide qualifications of service/start-up personnel.

21. Material Certification:

    a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of five (5) years. Based on incompatibility with the service conditions, provide technical data and provide proposed materials.

    b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

22. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required.”

    a. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

23. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

    a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

    b. Failure to include a copy of the marked up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. General:

1. Do the work required by and in accordance with applicable State and local codes; arrange for all permits, inspections and tests required by these codes. Provide systems and items of equipment that conform to applicable safety standards including those for safety of personnel.

2. One vendor to provide equipment and appurtenances, regardless of manufacturer, and is responsible for the satisfactory operation of the systems. Substitutions on functions specified are not acceptable.

3. Provide components to manufacturer's standard for service intended unless otherwise required.

4. Pumps of the same type to be the product of one manufacturer. Provide equipment of manufacturers' latest and proven design. Pumps to be standard cataloged products.

C. Service:

1. Services of Manufacturer's Representative stated in Section 01 43 00 and as specified herein.

2. Provide services of factory-trained Service Personnel, specifically trained on type of equipment specified.

a. Submit qualifications of Service Engineer for review.

b. Person-day requirements listed exclusive of travel time, and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.

c. Installation: Sufficient time to assist in location of anchor bolts; setting, leveling, alignment, field erection, etc.; coordination of piping, electrical, miscellaneous utility connections, but not less than:

(1) 0.5 person-days.

d. Start-Up: Sufficient time for calibration, testing and start-up, but not less than:

(1) 0.5 person-days.

e. Performance Testing: Time for field acceptance testing, but not less than:

(1) 0.5 person-days.

f. Instruction: Sufficient time for classroom and/or field operation and maintenance instruction, but not less than:

(1) 0.5 person-days.

g. Credit to the Owner unused service person-days specified above at the manufacturer's published field service rate plus any costs of travel.

3. The minimum days specified above does not relieve the manufacturer of responsibility of providing sufficient service to place components and systems in satisfactory operation. Provide, in addition to time periods specified above, time and material used to correct defective equipment at no additional cost to Owner.

4. 8-hour days specified are exclusive of travel time.

5. Turn on no form of energy to any part of systems prior to receipt by Engineer of certified statement of approval of installation from Contractor containing his supplier's authorization to energize system unless done by the supplier's servicemen may do so for purposes of checkout.

6. The Manufacturer's Representative must maintain a factory trained serviceman with parts within 150 miles of this Owner.

D. Pumps, Motors and Controllers:

1. Pump manufacturer shall furnish the pumps, motors and variable frequency drives, if required, regardless of manufacturer, as a complete package to ensure proper coordination and compatibility of equipment.

2. Prior to shipment to job site, pump manufacturer must perform a test on the combined motor and pump assembly.

1.05 SPARE PARTS:

A. Furnish following spare parts, identical and interchangeable with similar parts installed in work:

1. For each metering pump:

a. Two replacements for each tube/hose.

b. Two complete sets of gaskets.

2. Provide all other manufacturer's recommended spare parts necessary to maintain each piece of equipment for a period of one year.

B. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which they are intended.

C. Deliver spare parts at same time as equipment to which they pertain. Properly store and safeguard such spare parts until completion of work, and then deliver to Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Pump capacities and operating data are indicated in the Process Pump Schedule.

B. Spent Deicing Sample Fluid

1. The peristaltic (hose) pump (SD-DP-3) will be used to pump sample spent deicing fluid from the Spent Deicing Discharge Meter Box to the TOC analyzer within the Mixing-Dosing building. The pump will be located on top of the Spent Deicing Discharge Meter Vault with the suction inside the vault upstream of the meter.

2. The liquid will consist mainly of spent deicing fluid as defined in Section 46 41 50.03: Hydraulic Mixing System and Appurtenances.

3. Refer to pump schedule for flow rates.

2.02 GENERAL:

A. Provide systems constructed of components which are compatible and suitable for intended service.

B. Drawings and specifications indicate energy sources that will be provided. Provide all other devices necessary to obtain proper operation of system from these energy sources.

2.03 PUMP CONTROL PANELS:

A. Provide factory wired panels in accordance and with the following:

1. Panels to be fabricated in accordance with Section 40 90 00.

2. NEMA Type 4X enclosures of fiberglass reinforced polyester, gasketed to prevent chemical corrosion. Aluminum NOT ACCEPTABLE. Provide electrical control items that are rated NEMA Type 4, unless otherwise specified.

3. Instruments and accessories to be as specified in Section 40 90 00.

4. Accessories mounted and wired to terminal strips or bulkhead fittings and properly identified to provide ease of field connection.

5. Controls for electrically operated or motor-driven equipment, with appurtenances, to require only terminal wiring and connections to equipment.

6. Control contacts rated not less than 10 amperes on 120 volts and gold plated contacts for low current instrument signals.

7. Lamicoid nameplates with filled engraved legends.

2.04 PUMPING EQUIPMENT:

A. Hose Metering Pumps:

1. Manufacturers:

a. Watson-Marlow.

b. Verder.

c. Larox.

d. Eccentric.

2. Gear Motor/Reducer

a. Flender, Elgin, IL.

b. Nord, Waukesha, WI.

c. SEW Eurodrive, Troy, OH.

3. Pump Construction:

a. Pumping assemblies, including pump and driver, to operate within vibration and bearing temperature limits specified over the full operable range of the pump assembly.

b. Design and proportion all parts of pump for the service specified and indicated.

c. Provide room for inspection, repair and adjustment.

d. Apply a never seize compound to all bolts.

4. Pump Type:

a. Positive displacement, hose type pump.

(1) Capable of operation in either direction without flow variation or change in metering capability.

(2) Capable of running dry without damage to pump or hose.

(3) Capable of pulling 95 percent of full vacuum throughout life of hose.

(4) Metering accuracy: +5 percent, repeatability: +1 percent, both throughout life of hose.

(5) Valveless with no dynamic seals in contact with the pumped product.

(6) Minimum pressure rating: 1-inch and larger, 220 psi, 3/4-inch and smaller, 109 psi.

5. Pump Housing and Cover:

a. Material:

(1) Housing: Cast Iron, ASTM A48 Class 35 (DIN GG25).

(2) Cover: 1-inch and larger carbon steel, ASTM A570 GR36, 3/4-inch and smaller, polycarbonate or carbon steel.

b. Provide housing capable of rotation in 90 degree increments.

c. Provide ribs for strength and for heat dissipation.

d. Provide a housing cover O-Ring Seal.

(1) Chemical Services: Material as recommended by the pump manufacturer for the service conditions specified and indicated.

e. Fill approximately 40 to 50 percent of the pump housing with hose lubricant containing a combination of 99.5 percent pure glycerine and mono-propylene glycol to provide a medium for cooling and lubrication. Lubricant to be food grade.

f. Support pump housing by means of a welded ASTM A36 structural steel frame and baseplate.

6. Connections:

a. Provide flanged suction and discharge connections for all pumps, faced and drilled to 150 lb. ANSI Standard PN10.

(1) Chemical Services: Provide flange, hardware and hose insert material as follows:

(a) Spent Deicing Fluid: Type 316 stainless steel.

(2) Hose clamps and hardware: Type 316 stainless steel.

7. Hose:

a. Two or four layer braided nylon reinforced, three layer elastomer compatible with the service specified. Other hose constructions are acceptable provided all requirements specified are met. Chemical Services: Material as recommended by the pump manufacturer for the service conditions specified.

b. Burst Pressure Rating: 600 psi

c. 53-68 Shore A Durometer.

d. Machine hose outside diameter to a wall thickness tolerance of +0.3 mm tolerance.

e. Maximum Working Pressure:

(1) Pumps 3/4-inch and smaller: 109 psi

8. Shafts:

a. Alloy steel ASTM A322/4140, minimum.

b. Provide shafting adequate to operate pumps at maximum pressure specified or maximum pressure capability of drive whichever is greater.

c. For pumps 1-inch and larger provide two-way seals. Provide lip seals for rotor shaft for pumps 3/4-inch and smaller.

9. Rotor Assembly:

a. Material:

(1) Rotor: Cast Iron, ASTM A48 Class 40 (DIN GG25)

(a) Rotor Shoe: Polished Aluminum BS1490. Provide ability to shim for compression adjustment. Mount Shoes 180 degrees apart.

1) For pumps 3/4-inch and smaller, provide separate shoes as specified above or a one piece rotor design with integral shoes.

(b) Shims: Galvanized steel. Non-metallic shims are not acceptable.

(2) Hose shall be replaceable without cover or pump removal.

(3) Shoes shall be adjustable for shimming without removing the pump housing cover.

10. Bearing Frame:

a. Use antifriction type, minimum B-10 life of 100,000 hours at maximum operating speed and pressure. In accordance with AFBMA references.

b. Provide permanently greased bearing. Provide a plugged grease fitting.

c. Pumps without bearing frames are unacceptable.

11. Coupling:

a. High torque, all metal gear couplings with external grease fittings.

b. Service Factor: 1.50 based on motor nameplate rating.

12. Leak Detection Systems:

a. Provide one sensor on each pump to detect leakage of pumped product into pump housing, hose failure.

b. Provide a float type device or capacitance sensor located near the top of the pump housing for hose failure alarm and pump shutdown. Locate on backside of pump housing.

c. Sensor to send a signal to sound an alarm and turn pump off automatically. Provide sensor with normally open contact.

d. Sensor: 24 volt.

B. Hose Pump Drive System:

1. Motor:

a. Provide motors in accordance with Section 26 20 00 and as specified.

b. Provide squirrel cage induction motor with C-face design, integral gear reduction units are not acceptable.

(1) Provide motor with adequate cooling at lowest operating speed.

c. Insulation: Minimum Class "F" with Class "B" temperature rise, 105 degrees F ambient unless otherwise indicated or specified.

d. Service Factor: 1.15.

e. Provide ball or roller bearings, in accordance with AFBMA Standard 9-90 and Standard 11-90; minimum L-10 life of 100,000 hours.

f. Premium efficient motors, nominal and minimum motor efficiencies per NEMA MG1.

g. Rating: 120V, 1-ph, 60 Hertz.

2. Gear Reducer:

a. Provide helical gear or planetary arrangement classified for continuous, AGMA Class II, 24 hour duty.

b. Provide ASTM A48 Class 30 cast iron housing.

c. Gears: Case hardened alloy steel forgings with precision ground gear teeth minimum AGMA quality 12.

d. Provide horizontal parallel or bevel right angle shafting, arrangement as indicated in the process pump schedule.

e. Design reducer to match output speed requirements of pumps; double or triple reduction.

f. Match torque-rating of pumping equipment.

g. Minimum gear reducer service factor 1.50 minimum, based on peak running torque of pump.

h. Gear reducer minimum efficiency:

(1) Double Reduction: 97 percent.

(2) Triple Reduction: 95 percent.

C. Hose Pump Baseplates:

1. Bolt pump and drive to a common baseplate and frame.

2. Fabricate baseplate of ASTM A36 fabricated structural steel. Bent form baseplates are not acceptable for pumps 2-inch and larger. For pumps 3-inch and larger provide a balance foot on pump base located under pump housing.

3. Provide at least one 4-inch minimum diameter grout hole or equivalent and provisions for anchor bolts. Provide base drilling for anchor bolt holes readily accessible from exterior width dimension of the base. Anchor bolt holes which are concealed or partially concealed by channel base frames are not acceptable.

4. Design baseplate with adequate strength to support pump and driver.

5. For pumps 2-inch and larger: Provide Type 316 stainless steel jacking bolts on each side of gear reducer.

6. Provide machined surfaces for bearings pads for pumps 2.5-inch and larger.

7. Provide Type 316 stainless steel or rigid fiberglass guard in conformance with applicable OSHA requirements.

8. Pumps shall be installed on concrete foundations as specified and indicated.

D. Pump Assembly Cabinet: The Pump, motor, valves, piping, display and all appurtenances shall be factory installed and totally enclosed in a NEMA 4X, (IP66) wash-down enclosure for in the field operation.

1. Enclosure: The pump with all electrical equipment will be enclosed in a stainless steel 304 field cabinet with full length doors to open and maintain the equipment inside.

2. Rated NEMA 4X (IP66).

3. Provided with 316SS floor/shelf level mounting brackets and hardware. Optional: provide extended height brackets for mounting pump 4.5 inches above grade level.

4. All field displays will be protected against direct sunlight and will be shaded for ease of reading without glare on the display screen.

5. Provide front panel user touchpad controls for stop/start, configuration menu access and navigation, and operating mode selection.

2.05 METERING PUMP APPURTENANCES:

A. Pressure Relief Valves:

1. Provide bypass valves where indicated on drawings. Provide pressure relief of polyvinylchloride or CPVC construction, and having Hypalon or Teflon diaphragms, suitable for the fluid being pumped, to protect upper works of valve from process fluid. Provide spring opposed diaphragms with loading pressures adjustable by means of screw in top works. Field-adjust valves to settings required of the system. Setting to be the maximum pressure to occur downstream of the valve, as installed in system, while pump is operating.

2.06 SHOP PAINTING

A. Provide as specified in Section 09 91 10 Shop Painting and 09 96 00 High Performance Coatings for pump casings.

B. Give a shop coat of grease or other suitable rust-resistant coating to ferrous surfaces obviously not to be painted.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install equipment and appurtenances in accordance with manufacturer's printed instructions, as indicated and specified.

B. Install pumping units on a concrete pad. Assure there is no pipe stress on pump piping connections.

3.02 FIELD CALIBRATION AND TESTING:

A. General:

1. Coordinate testing with operation of other portions of the facility. Arrange for temporary piping and wiring modifications which may be needed if fluid cannot be fed at intended dosing points, or if other interconnected electrical equipment is not operational.

2. Calibrate in the presence of the Engineer.

3. After cleaning, completely test each fluid feed system to verify that equipment is capable of performing its specified function in satisfactory manner without mechanical or electrical defects, binding, or operational difficulties. Correct defects and deficiencies and repeat all tests until satisfactory results are obtained. Correct excessive vibration leakage or noise. Make connections watertight or dusttight.

4. Demonstrate accuracy of units and bring within limits specified herein.

5. At the time of the tests, make final adjustments necessary to place equipment in satisfactory working order.

6. Water testing is permitted where appropriate for preliminary testing purposes; however, conduct acceptance tests using appropriate chemicals for which each system was designed.

7. Complete preliminary and calibration testing and corrections prior to acceptance testing, as specified herein, to be conducted with the manufacturer's technical representative.

8. Copies of tests to be furnished to the Engineer.

9. Neutralize and dilute chemicals wasted during testing procedures with 10 volumes of water prior to disposal into plant drain system. Direct dumping into drains without prior neutralization and dilution is hazardous and not permitted.

10. Identify any exceptions to specification in documentation.

B. Peristaltic Pumps (Acceptance Tests):

1. Submit five copies of manufacturer's preliminary and calibration pump curves showing numerical values of pump discharge to nearest tenth of a gallon per hour.

2. Perform testing at 100, 75, 50 and 25 percent of speed settings.

3. Submit five copies of individual pump calibration curves to Engineer at least 15 days prior to acceptance testing. Notify Engineer in writing when pumps are ready for acceptance testing, and make no adjustments or modifications to pumps after that time, without written permission of Engineer.

4. During acceptance testing demonstrate correct functioning of control stations.

5. Perform testing in the following manner:

   a. Test pumps by filling a calibrated container inside the Mixing-Dosing building with spent deicing fluid, and measuring time to pump a given volume out of the suction pipe, with all other equipment valved off. Make test measurements of at least fifty seconds duration, using two stopwatches reading time to nearest one-hundredth second. Discard measured times differing more than one-half second. Average times differing by one-half second or less. Record averaged time for use in determining acceptability of pumps.

6. To determine deviation, compare measured pump output at various settings with output indicated by manufacturer's calibration curves. Pumps with deviation greater than plus or minus 3.0 percent of maximum pump output are not acceptable. Add one percent to allowed tolerances specified herein for pumps having variable speed drives.

7. Add 0.5 percent to the deviation for the slurry pumps acceptance.

8. Demonstrate pumps are capable of pumping zero flow at zero percent stroke, 100 percent speed settings. Pumps unable to meet this requirement are not acceptable.

9. If pump output varies excessively, it is possible the pump is air bound. Operate pump for five minutes at back pressure valve setting of 50 psig. Pumps unable to relieve themselves of air within five-minute period are not acceptable.

10. Operate pumps for period of four hours to demonstrate satisfactory operation.

3.03 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 46 33 44

SECTION 46 33 93.01

POLYETHYLENE CHEMICAL STORAGE TANKS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test plastic chemical storage tanks and appurtenances as indicated and in compliance with Contract Documents.

B. Provide each chemical storage system complete in details and before acceptance make each system fully operational and ready for use by the Owner.

C. Chemical for testing to be supplied by the Owner.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B-16.5: Pipe Flanges and Flanged Fittings

B. ASTM International (ASTM):

1. D638: Standard Test Method for Tensile Properties of Plastics

2. D648: Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

3. D746: Specification for Polyethylene Tank Testing

4. D790: Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

5. D883: Definitions of Terms Related to Plastics

6. D1505: Density by Density Gradient Technique

7. D1693: Environmental Stress Crack Resistance

8. D1998: Standard Specification for Polyethylene Upright Storage Tanks

C. Association of Rotational Molders (ARM):

1. Standard Low Temperature Impact Resistance

D. National Sanitary Foundation (NSF):

1. 61: Drinking Water System Components - Health Effects

E. National Fire Protection Association (NFPA):

1. 704: National Fire Rating System (NFR).

F. Occupational Safety and Health Association (OSHA):

1. 29 CFR Part 1910.27 Fixed Ladder

2. 29 CFR Part 1926.104 Safety Belts, Life Lines and Lanyards

3. 29 CFR Part 1926.500 Fall Protection

4. 29 CFR Part 1926.501 Fall Protection

5. 29 CFR Part 1926.502 Fall Protection

G. Uniform Building Code (UBC):

1. Tank Restraints.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. When the Contractor proposes tanks which requires an arrangement differing from that indicated on the drawings or specified, prepare and submit for review detailed structural, mechanical, and electrical drawings and equipment lists, utilities consumption schedule and operating instructions, showing all necessary changes and embodying all special features of the equipment he proposes to furnish. Make changes, if accepted at no additional cost to Owner.

2. Operating and maintenance instructions and parts lists.

3. Shop drawings data for accessory items.

4. Templates or certified setting plans, with tolerances, for anchor bolts.

5. Number and identify components to correspond with terminology on drawings. Use these numbers on all submittal sheets and shop drawings.

6. Recommendations for short and long term storage.

7. Sales bulletins or other general publications are not acceptable as submittals for review except where necessary to provide supplemental technical data.

8. Provide a listing of the materials recommended for each service specified and indicated.

9. ISO 9000 series certification or other quality control manual demonstrating a complete system for quality management.

10. Tank manufacturers must be capable of providing a list of customers using at least five (5) similar tanks for the same chemical applications for at least ten (10) years.

11. Material Certification:

a. Provide certification from the manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of three (3) years. Provide proposed materials at no additional cost to the Owner.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

12. Certified results of factory tests.

13. Recommended baffle design.

B. Special Requirements:

1. Manufacturer's specification, catalog data and illustrations.

2. Tank heating calculations.

C. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required".

1. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in rejection of the entire submittal with no further review and consideration.

1.04 QUALITY ASSURANCE:

A. Do work required by and in accordance with applicable State and local codes; arrange for permits, inspections and tests required by these codes; and provide complete systems ready for use. Provide tanks and accessories that conform to applicable safety standards including those for safety of personnel.

B. Provide components to manufacturer's standard for service intended unless otherwise required.

C. Provide components and accessories of manufacturers' latest and proven design.

D. The drawings and specifications direct attention to certain required features of the tanks, but do not purport to cover details entering into its design, construction and installation; nevertheless, provide tanks so that systems will be complete and ready for operation.

E. Provide supervisory services for satisfactory installation, with factory-trained serviceman to assist in determining location and orientation.

F. Coordinate the work schedule of other parts of the chemical systems manufacturer's service personnel during construction, testing, start-up, and acceptance, to coordinate with the tank manufacturer.

G. Upon completion of the installation, provide services of above serviceman for field testing.

H. Clean tanks internally prior to shipping.

I. Shop test and provide certificates as specified.

J. Turn on no form of energy to any part of system prior to receipt by Engineer of certified statement of approval of installation from Contractor containing his supplier's authorization to energize system unless done by the supplier's servicemen may do so for purposes of checkout.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. General:

1. Tank shall be an intermediate bulk container (tote) with a capacity of 260 gallons.

2. Provide tank configurations as indicated.

3. Clean tanks internally prior to shipment to meet NSF 61. Ship tanks protected to prevent damage to tanks and their protective coatings.

4. Provide spill containment container to be positioned under the chemical tank with a volume of 110% the chemical tank. The container will be designed to take the full load of the chemical tank when full.

5. Provide intermediate bulk container with stainless steel reinforcement protection cage.

2.02 TANKS:

A. Cross-Linked Polyethylene Tank(s):

1. Cross-Link Polyethylene Tank Fabricators:

a. Assmann.

b. Poly Processing.

c. Snyder.

2. Provide High Density Cross-Linked Polyethylene Vertical/Horizontal storage tank, with all accessories as specified.

3. The HDXLPE Tanks shall be as manufactured in accordance with the definitions given in ASTM-D1998 Type I (Standard Specification for Polyethylene Upright Storage Tanks). The tanks shall be manufactured by the rotational molding process.

4. The tanks shall be designed for 1.90 Specific Gravity using a hoop stress value of no greater than 600 psi at 100 degrees F, with a safety factor of no less than 2, using the Barlow Formula for calculating wall thickness. For applications in excess of 100 degrees F design conditions, lower values for the design hoop stress shall be used.

5. The tank shall be molded from a virgin High Density Cross-Linked Polyethylene resin, with no fillers.

6. The tank will be equipped with the facility for the following instruments and piping:

   a. Suction hose

   b. Pressure relief return hose

   c. Level sensors

   d. The tank shall have at least two circular openings of minimum 6-inch diameter to accomodate the equipment mentioned above. Openings on the tank shall be on the tank roof with the openings beginning not less 12 inches from the edge of the tank without compromising structural integrity.

7. The openings on the tank shall be provided with liquid tight screw caps.

8. Impact Test: Shall be done in accordance with ASTM D746. Standard method shall be used in this test.

9. The nominal value for the properties of the polyethylene plastic material shall be as follows, as supplied by the resin suppliers.

Test Procedure	Units	XLPE	HDPE
Density/ASTM D1505	g/cc	0.940 to 0.945	0.939
ESCR Cond. A, F50/ASTM D1693 10 Percent Igepal	Hrs.	>1000	1000
Tensile Strength/ASTM D638	psi	2,600	3,900
Flexural Modulus/ASTM D790	psi	1000,000 to 110,000	86,500
Heat Distortion Tem./ASTM D648 At 66 psi	Degrees C	67 Degrees	-
Long Term Hydrostatic (LTHS) (Creep)	psi	900	-
FDA-grade resin	-	No	Yes
UV-stabilized	-	Yes	Yes

10. The tanks shall be designed with a safety factor of no less than 2 at an ambient temperature of 100 F.

11. Test pressure shall be minimum 14.6 psi.

12. All edges cut out for openings shall be trimmed to have smooth edges.

2.03 TANK ACCESSORIES:

A. Sight Gauge:

1. To be provided with one PVC/CPVC tank sight gauge isolation valve. Bottom valve to have a drain for the sight gauge.

2. Provide a clear PVC sight gauge of a material resistant to U.V.

2.04 TANK SIGNAGE:

A. National Fire Rating (NFR):

1. Provide signage for the National Fire Rating System (NFR) designation conforming to NFPA 704, for the chemicals contained in the tanks.

2. Provide two (2) signs per tank. Location to be determined in the field by the Engineer for proper visibility.

3. Signs to be vinyl, screen printed with UV resistant inks, and a minimum of 18 inches per side. No mechanical fasteners are allowed.

B. Provide signage for identifying for the chemicals contained in the tanks.

1. Provide two (2) signs per tank. Location to be determined in the field by the Engineer for proper visibility.

2. Letters to be 6-inches high, colors of letters and background to be submitted for acceptance. Signs to be vinyl and screen printed and UV resistant inks. No mechanical fasteners are allowed.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install tanks in accordance with printed instructions of fabricators, as indicated and specified.

1. Do not use fittings for handling.

2. Install on spill containment container.

3. Provide pad as recommended by the tank supplier.

4. Assure there is no stress on tank nozzles.

3.02 FIELD PAINTING:

A. Specified in Section 09 91 13.

3.03 ACCEPTANCE TESTING:

A. Tanks:

1. Owner will provide all chemicals for testing.

2. Supply all pipe, hose, pumps, water, power and other equipment required to convey the test liquids and carry out the tests.

3. After installation, clean tanks of loose debris and dry prior to tests.

4. Test tanks for leaks or damage prior to use. Certification to ASTM D-1998.

5. Test tanks with water first and then with specified chemical.

6. Do not test acid tanks with water; use air at pressure of 5 psig for one hour prior to test with acid.

7. Test tanks with each liquid for period of 24 hours during which no visible leakage is acceptable.

8. Where hydrostatic testing of tanks is specified, apply required hydrostatic test pressure in addition to pressures imposed by filling tank with required liquid. In order to simulate these conditions, attach standpipe to top of tank, and fill tank and standpipe assembly with water. Measure height of standpipe above highest point of tank. Provide standpipe of height equal to height of tank times difference between specified gravity of required liquid and specific gravity of water, plus additional height equal to hydrostatic test pressure specified. Leakage during four hour test not acceptable.

9. Repair leaks or damage by tradesman skilled in that type of work at no cost to the Owner.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 46 33 93.01

SECTION 46 41 50.03

HYDRAULIC MIXING
SYSTEM AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Design, provide and test spent deicing fluid storage tank pump mixing systems, controls, control panels and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME) Standards

1. ASME B31.3 Process Piping Design

2. ASME B16.5: AN Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

B. ASTM International (ASTM):

1. A36/A36M: Standard Specification for Carbon Structural Steel.

2. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. A105: Standard Specification for Carbon Steel Forgings for Piping Applications

4. A181: Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

5. A193: Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications

6. A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

7. A240/A240M: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and General Applications.

8. A276: Standard Specification for Stainless Steel Bars and Shapes.

9. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

10. A312: Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless-Steel Pipe.

C. AWWA Standards:

1. AWWA C200: Standard for Steel Water Pipe – 6 in. and Larger

2. AWWA C217: Standard for Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for Exterior of Special Sections, Connections, and Fittings for Buried or Submerged Steel Water Pipelines

D. Reference Specifications:

1. Section 43 21 00.23: Process Pumps and Appurtenances

2. Section 40 23 19.05 Process Piping and Appurtenances

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Data regarding system characteristics and performance:

2. Shop drawing data for accessory items.

3. Hydraulic calculations including for surge (water hammer).

4. CFD analysis of pump tank mixing systems proving mixing within the specified performance limits.

5. Manufacturer's literature as needed to supplement certified data.

6. Operating and maintenance instructions and parts lists.

7. Listing of reference installations as specified with contact names and telephone numbers.

8. List of recommended spare parts other than those specified.

9. Shop testing certificates

10. Shop and field inspection reports.

11. Qualifications of field service engineer.

12. Recommendations for short and long-term storage.

13. Special tools.

14. Number of service person-days provided and per diem field service rate.

15. Provide a listing of the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.

16. The latest ISO 9001 series certification.

17. Material Certification:

a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions

specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of three (5) installations in operation for a minimum of five (5) years. Provide proposed materials at no additional cost to the Owner.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required” or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS:

A. Comply with the requirements specified in Section 01 61 00.

B. Provide spare parts that are identical to and interchangeable with similar parts installed.

1. One set of all special tools required.

2. Provide spare rotating assemblies as indicated in the Process Pump Schedule.

a. The assembly shall consist of a complete bearing frame, bearings (one of each), mechanical seal (two) and pump-motor coupling (pre-packed in durable wooden crates).

b. At least one spare mixing nozzle for every five nozzles installed.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Hydraulic mixing systems and controls shall be the product of one manufacturer.

C. Hydraulic mixing systems and controls shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications and the service conditions specified and indicated.

D. Welding: In accordance with latest applicable American Welding Society Code or equivalent.

E. Shop tests as specified.

F. The Contractor shall design and obtain the nozzles, nozzle supply piping, pumps, and appurtenances from the mixing system manufacturer, as a complete and integrated package to insure proper coordination and compatibility and operation of the system.

G. Services of Manufacturer's Representative as stated in Section 01 43 00 and as specified herein.

H. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must have a minimum of five (5) years of experience, all within the last seven (7) years, on the type and size of equipment.

2. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

3. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:

    a. 3 person-days.

4. Functional Testing: Calibrate, check alignment and perform a functional test with water. Tests to include all items specified.

    a. 5 person-days.

5. Field Performance Testing: Field performance test equipment specified.

    a. 5 person-days.

6. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

    a. 3 person-days.

7. Credit to the Owner, all unused service person-days specified above, at the manufacturer's published field service rate.

8. Any additional time required of the factory trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

I. Manufacturer of mixing systems shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

J. If equipment proposed has more nozzles, larger piping or different controls than specified and indicated; provide all mechanical, electrical and instrumentation revisions at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. Design and provide spent deicing fluid storage tank mixing systems to intermittently and sequentially inject a mixture of water and varying concentrations of propylene glycol and other deicing chemicals through nozzles located on the tank bottom to completely mix the chemical storage tank contents using no moving parts located within the tank.

B. The main constituents of the spent deicing fluid on average is as follows (other deicing chemicals may also be applicable):

✓ Type I Propylene Glycol Mix	864,000 gallons per 3 days
✓ Type IV Propylene Glycol	108,000 gallons per 3 days
Subtotal	972,006 gallons
✓ Glycol Fluid Captured	70% Type I, 20% Type IV
✓ Glycol Fluid Discharged to Storm	
✓ Type I	604,802 gallons per 3 days
✓ Type IV	21,601 gallons per 3 days
Subtotal	626,409 gallons
✓ Stormwater	
(0.5 inch x 46 acres) = 83,490 cu. ft./day	
Or	1,873,641 gallons per 3 days
Total Volume	2,500,050 gallons per event

C. The contractor will be responsible for designing the tank mixing system including all the pumps, (for minimum and maximum flow rates), sizing of pipes, valves, nozzles, inline mixers, the caustic soda dosing ports and instrumentation connections, without changing the configuration of the system outside the tanks, as presented on the contract drawings.

D. The configuration of the mixing system outside the tanks will remain as per the drawings except for pipe diameters that will be sized by the contractor to ensure conformance with the mixing efficiency as specified.

E. The mixing nozzle configuration inside the tanks as presented on the drawings are only indicative and the contractor will design and provide a fully functional system by optimizing the size, position, configuration and quantity of the nozzles and nozzle pipework. The dimensions and position of the tanks and mixing building are fixed.

F. Mixing inside the tanks will be for all tank levels from full to a minimum of 5% or less without crating plumes that can cause odors or influence the tank liquid level instrumentation negatively.

G. The spent deicing facility will mainly be operational during the winter months but spent deicing fluid may be stored for many months in the tanks into the summer months during which continuous mixing will be required. There may however be several months or years during which the system will not be operational, and the design will allow for equipment to also withstand these conditions.

H. The piping system material and corrosion protection will have a design life of at least fifty (50) years and all mechanical and electrical equipment and instrumentation installed shall have a design life of at least thirty-five (35) years, taking into consideration reasonable care and maintenance during this period.

I. Nozzles can either be of hardened steel, stainless steel or vulcanized rubber to withstand potential acidic conditions and the presence of potential grit, stones and sand particles. Some hydrocarbons may also be present in the spent deicing fluid.

J. Definitions:

1. Tank: The chemical storage tanks within which mixing occurs.

2. Nozzle Supply Pipe: Piping between nozzles in the storage tank and the pumps.

3. Nozzle: Floor-anchored, large liquid-emitting device to guarantee efficient mixing of spent deicing fluid.

2.02 MANUFACTURERS:

A. Hayward Gordon: HydroMix

B. Red Valve: Tideflex

2.03 SEISMIC DESIGN REQUIREMENTS:

A. Conform to the requirements indicated on the structural drawings and as specified in Section 01 41 20.

B. The Contractor shall conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all equipment bases, anchorage, supports and foundations designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Unit Responsibility, certification for all equipment signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

2.04 MIXING SYSTEM CONSTRUCTION:

A. Performance Requirements:

1. Tank Mixing: Uniform throughout the tank at stated minimum flow requirements for the chemical/storm water/spent deicing fluid specified and indicated.

2. Mixing system manufacturer to complete a computational fluid dynamics (CFD) analysis on the nozzle layout to ensure enough mixing occurs.

3. Mixing system designed to operate efficiently at varying tank levels.

4. Liquid Distribution and Balancing: Enough to maintain chemical mixing over entire depth of the tank at design flow requirements.

5. Mixing Performance: The spent deicing fluid should be mixed well such that the TOC (Total Organic Carbon) concentration at any location in the tank shall not vary by more than three (3) percent from the average concentration, independent of the tank level.

B. Fabrication:

1. Carbon steel, ASTM A53, Type S, Grade A OR B, Schedule 40, 80 OR 120. Lining and coating: steel pipes and fittings to be hot dip galvanized, (150-micron FFT) and

2. Carbon Steel Pipe Dimensions: ANSI B16.1.

3. Piping can also be manufactured from Stainless Steel 304L/316L in accordance with ASTM A 358, Class 1.

4. Stainless Steel Pipe Dimensions: ASME B36.10M, minimum Schedule 5

5. Shop fabricate welded metal parts and assemblies from stainless steel, ASTM A240/A240M, Type 316L with a 2D finish.

6. Shop fabricate non-welded parts and pieces from sheets and plates of stainless steel, ASTM A240/A240M, Type 316 or from bars of stainless steel ASTM A276, Type 316, unless specified otherwise.

7. Welds and Welding Procedure:

   a. Shop weld with filler wire using MIG, TIG or shield-arc, or plasma-arc welding inert gas processes. Provide a cross-section equal to or greater than parent metal.

   b. Provide full penetration butt welds to interior surface with gas shielding to interior and exterior of joint.

   c. Provide smooth, even distribution interior weld beads with an interior projection not exceeding 1/16-inch beyond inner diameter of nozzle header or fittings.

   d. Field welding is not acceptable.

C. Pumping System

1. Provide in accordance with Section 43 21 00.23, Process Pumps and Appurtenances.

2. Pumps are to be equipped with VFDs to allow flow and mixing to vary with the tank level.

3. One pump can be used for both tanks when tank level is low and to prevent surface plumes.

4. Piping from the tank to a truck docking stations is required and VFDs and other flow control devices should be used to reach the desired flow rate of 650 gpm to a container truck loading the spent deicing fluid.

5. The Contractor will do a full hydraulic analysis to determine the flow rates required for the mixing system taking into consideration the pipe sizes and all valves and fittings in the system. The maximum operating pressure will be used to select the pressure classes of pipes and fittings including the pressure rating of the dosing pumps and all instrumentation. A surge analysis will be conducted to determine the maximum surge pressure under various operating conditions including a pump trip. The maximum negative pressure will also be determined, and mitigation measures will be put in place to protect the pipes and equipment against minimum and maximum pressures.

6. The pump and motor designed by the Contractor will not exceed the HP of the electrical equipment allowed for in the specifications and drawings.

D. Nozzle Supply Piping

1. No threaded connections will be allowed. All joint and connections will either be flanged or welded.

2. Piping: Schedule 5S, Type 316 stainless steel PressFit technology system comprised of stainless steel PressFit technology fittings, couplings, and pipe in accordance with Section 40 23 19.04.

3. Pipe: Type 316/316L ASTM A312 stainless steel

E. Nozzles

1. Design and Fabrication: Mixing system manufacturer must determine optimal sizing of the nozzles to guarantee performance.

2. Configuration: Mixing system manufacturer must design an optimal nozzle configuration to guarantee performance.

3. Calculate all thrust forces, design pipe supports and anchors accordingly and reinforce the tank floor and walls to accommodate these forces.

4. Adhesive Anchor Bolts: Hilti HIT-RE 500. Provide two anchor bolts installed per nozzle, one each on opposite diagonal corners.

F. Appurtenances

1. Miscellaneous: Nuts, bolts, washers, and other non-welded parts shall be stainless steel, ASTM A240/A240M, Type 316. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

2. Lifting Lugs: Provide attached for equipment assemblies and components weighing over 100 pounds.

G. Mixing System Fluid:

Service/Spent deicing Fluid/% Solution	52% max, < 1% min
Spent deicing Fluid S.G.	1.00 ±5%
Spent deicing Fluid, % solids	Minimal (~2%)
Spent deicing Fluid, pH	3.5-8.5
Number of Tanks	2
Tank Diameter, ft	80
Tank Liquid Depth, ft	33.25
Tank Maximum Liquid Depth, ft (m)	34.25
Tank Straight side Length, ft (m)	35.25
Area Classification	NEMA 4X

2.05 GAUGES:

A. Gauges: Operating range at approximately mid-point of the gauge range.

2.06 SHOP TESTING:

A. Provide shop testing of all pumps.

B. Shop test all preassembled piping to 50% above maximum operating pressure (including surge pressure) and correct all leaks and retest piping.

1. Provide testing certification.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with accepted shop drawings, manufacturer's printed instructions and as indicated.

3.02 FIELD TESTING:

A. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters and a completed and signed pretesting check list. See Division 1 for checklist.

B. After installation of mixing systems and piping, and after inspection, operation, testing and adjustment have been completed by the manufacturer’s field service technician, conduct operating test for each mixing system in presence of the Engineer to determine its ability to operate within the range specified and indicated, and to deliver its rated capacity under specified conditions.

1. During tests, observe and record pressure and flow rate.

a. Test Duration: Determined by the Engineer, but not less than three hours of continuous operation at each condition specified and indicated.

b. Mixing Test: For a full tank, six spent deicing fluid test samples at equal depth intervals in a straight vertical arrangement shall be taken from the access hatch on top of the tank. The TOC (Total Organic Carbon) concentration for each sample shall be determined by an independent laboratory and the TOC for all samples shall be within plus or minus 3% of the concentration of the average of the six samples.

c. Mixing Test: For a half full or less tank, four spent deicing fluid samples tested, and concentration shall be within the limit as stated in b. above.

d. At least three series of tests will be conducted on three different days.

2. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.

3. Repeat tests until specified results are obtained.

4. Contractor to provide all labor, piping, testing equipment, equipment, flow meters and test gauges for conducting tests.

a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters. All calibrations must be within 10 days of the field testing.

b. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.

c. Contractor is responsible for delivery and disposal of water used for testing.

C. Make all adjustments necessary to place equipment in specified working order at time of above tests.

D. Remove all replace equipment at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that equipment will perform the service specified, indicated and as submitted and accepted.

3.03 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION 46 41 50.03