# JORDAN VALLEY WATER CONSERVANCY DISTRICT
## WEST JORDAN, UTAH

## JORDAN VALLEY WATER TREATMENT PLANT FILTER AND CHEMICAL UPGRADES

**CLIENT PROJECT NO. 202001**

**CONTRACT/TECHNICAL SPECIFICATIONS**

**100% SUBMITTAL**

**VOLUME 3 OF 6**

**DIVISIONS 10 - 16** ***(16050 to 16235)***

**FEBRUARY 2025**

7090 SOUTH UNION PARK AVENUE, SUITE 600 ▪ MIDVALE, UTAH 84047 ▪ P 801-233-2500

**JORDAN VALLEY WATER CONSERVANCY DISTRICT**

**JORDAN VALLEY WATER TREATMENT PLANT FILTER AND CHEMICAL UPGRADES**

# SEALS PAGE

Digitally signed by Stetson Sky Bassett
Contact Info: Carollo Engineers, Inc.
Date: 2025.02.13 20:30:52-07'00'

REGISTERED PROFESSIONAL ENGINEER
No. 12149234-2202
STETSON SKY BASSETT
STATE OF UTAH

Divisions 01, 11 (excluding 11265),
13 (excluding 13207 and 13447), 14,
15 (excluding 15122, 15229, 15400, 15430,
15500, 15735, 15740, 15745, 15762, 15812,
15814, 15830, 15936, 15954)

Section 06611

Digitally signed by Jacob C. Baer
Contact Info: Carollo Engineers Inc.
Date: 2025.02.14 12:44:29-07'00'

REGISTERED PROFESSIONAL ENGINEER
No. 7667716-2202
JACOB C. BAER
STATE OF UTAH

Division 02

Sections 15122, 15229

Digitally signed by J. Matthew Yates
Contact Info: Carollo Engineers, Inc.
Date: 2025.02.14 10:01:03-07'00'

REGISTERED PROFESSIONAL ENGINEER
No. 11390122-2202
J. MATTHEW YATES
STATE OF UTAH

Divisions 03, 04, 05, 06 (excluding 06611)

Sections 07900, 13207

Digitally signed by Michele E. Hollenbaugh
Contact Info: Carollo Engineers, Inc.
Date: 2025.02.14 09:01:41-07'00'

STATE OF UTAH
MICHELE E. HOLLENBAUGH
No. 9334258
LICENSED ARCHITECT

Divisions 07 (excluding 07900),
08 (excluding 08910), 09, 10

Digitally signed by Chad A. Green
Contact Info: Carollo Engineers, Inc
Date: 2025.02.14 09:57:51-06'00'

REGISTERED PROFESSIONAL ENGINEER
No. 10396275-2202
CHAD A. GREEN
STATE OF UTAH

Sections 08910, 11265, 15400, 15430, 15500, 15735, 15740, 15745, 15762, 15812, 15814, 15830, 15936, 15954

Digitally signed by Guy C. Ehlers
Contact Info: Carollo Engineers, Inc
Date: 2025.02.13 21:09:14-07'00'

REGISTERED PROFESSIONAL ENGINEER
No. 5329023
GUY C. EHLERS
STATE OF UTAH

Divisions 16, 17
Section 13447

## DIVISION 16 - ELECTRICAL

## DIVISION 16 - ELECTRICAL

## DIVISION 17 - INSTRUMENTATION AND CONTROLS

## VOLUME 5 OF 6

### APPENDICES

SECTION 16050

COMMON WORK RESULTS FOR ELECTRICAL

# PART 1 GENERAL

## 1.01 SUMMARY

A. Contract Drawings:
1. Schematic diagrams:
   a. Controls are shown as de-energized.
   b. Add relays, where required, provide necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
   c. Mount devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted.
2. Plan drawings:
   a. Electrical drawings show desired locations, arrangements, and components of the electrical Work in a diagrammatic manner.
   b. Locations and sizes of equipment are approximate only.
3. Installation details:
   a. Contract Drawings include typical installation details the Contractor is to use to complete the electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.
   b. Not all typical installation details are referenced within the drawing set. Apply and use typical details where appropriate.

B. Section includes:
1. Requirements for electrical:
   a. Basic design and performance criteria.
   b. Prescriptive requirements for common components.
   c. Installation.

## 1.02 REFERENCES

A. Abbreviations:
1. FAT: Factory acceptance test that is also referred to as source test.
2. ICSC: Instrumentation and controls subcontractor.
3. PCIS: Process control and instrumentation system.

B. Standards:
1. American National Standards Institute (ANSI).
2. National Electrical Manufacturers Association (NEMA):
   a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
3. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL).

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. LCP: Local control panel: Operator interface panel that may contain pilot type control devices, operator interface devices, control relays, etc., and does not contain a PLC or RIO.
   2. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
   3. Space: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment.
      a. Furnish hardware to accommodate the installation of future circuit breakers, instruments, relays, and controls.
      b. Wire relay and circuit breaker control power and network connections to the compartment and provide terminations.
      c. Space for future devices shall include:
         1) All necessary bus.
         2) Device supports and mounting equipment.
         3) Device connections to bus work.
         4) Wire troughs or raceway space.
   4. Spare: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that physically contains a device with no load connections to be made.
   5. Unequipped space: Portion of a switchgear, motor control center, panelboard, switchboard, or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.
   6. Vendor control panel (VCP): Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.

## 1.04 DELEGATED DESIGN

A. Requirements for Delegated Design are specified in the Technical Sections.

## 1.05 SUBMITTALS (NOT USED)

## 1.06 QUALITY ASSURANCE

A. General:
   1. Furnish equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Shipping precautions:
   1. After completion of shop assembly and successful factory testing, pack equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.

2. Place dehumidifiers, when required, inside the polyethylene coverings.
3. Skid-mount the equipment for final transport.
4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Loop drawings:
      a. Provide electrical information required in the preparation of loop drawings, including, but not limited to:
         1) Conduit numbers and associated signal(s) contained within each conduit.
         2) Wire numbers.
         3) Equipment terminal numbers.
         4) Junction boxes and signal(s) contained within each junction box.
         5) Equipment power sources, and associated circuit numbers.
         6) As-built drawings detailing wiring.
   2. Roof penetrations:
      a. Show roof penetrations for electrical equipment and conduit on the roof drawing Submittal and include equipment information:
         1) Type.
         2) Size.
         3) Location.
         4) Configuration of individual penetrations or large penetrations for multiple conduits.
         5) Weight.
         6) Anchoring and support details.

B. Meetings:
   1. As specified in Section 01312 - Project Meetings.

C. Sequencing and scheduling:
   1. Equipment anchoring: Project construction schedule must include an event for obtaining the anchor layout drawings from equipment manufacturers in adequate time for templates to be constructed and anchors to be cast-in-place.

## PART 2 PRODUCTS

### 2.01 GENERAL (NOT USED)

### 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide field wiring and terminations.

B. Equipment mounting and anchoring:
   1. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load specified in Section 01850 - Design Criteria, and other loads as required for proper operation of equipment.
      a. For equipment with an operating weight of 400 pounds or greater and equipment that is supported higher than 4 feet above the floor, provide calculations for:
         1) Operating weight and location of the centroid of mass for the equipment.
         2) Forces and overturning moments.
         3) Shear and tension forces in equipment anchorages, supports, and connections.
         4) Design of equipment anchorage, supports, and connections based on calculated shear and tension forces.
   2. Anchorage of equipment to concrete or masonry:
      a. Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
      b. Unless otherwise indicated on the Drawings, select and provide anchors from the types specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      c. Provide bolt sleeves around cast-in anchor bolts for 400 pounds or greater equipment.
         1) Adjust bolts to final location and secure the sleeve.
   3. Anchorage of equipment to metal supports:
      a. Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.

### 2.03 MANUFACTURERS (NOT USED)

### 2.04 MATERIALS

A. Enclosures:
   1. Provide enclosures for electrical, instrumentation, and control equipment, regardless of Supplier or Subcontractor furnishing the equipment, that meet the requirements of NEMA Standard 250.
      a. Provide metallic enclosures unless specifically indicated otherwise.

B. Stainless steel:
   1. Where stainless steel is indicated or used for any portion of the electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
   2. Provide exposed screws of the same alloys.
   3. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.

4. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

C. Plant area electrical Work requirements:
   1. Provide electrical materials in accordance with the following table, unless otherwise specifically indicated on the Drawings:
      a. Conduit installation requirements: As specified in Section 16130 - Conduits.

| Table 1. Electrical Material Requirements | | | | |
|---|---|---|---|---|
| **Plant Area** | **Environment:<br>W = Wet<br>D = Damp<br>C = Clean/dry<br>X = Corrosive<br>H = Hazardous** | **NEMA Enclosure Type** | **Exposed Conduit Type (as specified in Section 16130 - Conduits)** | **Support Materials** |
| Caustic Soda Building (Area 65) | W, X | 4X SST | PCS | SST |
| Chlorine Building (Area 63) | D, X | 4X Non-metallic | PCS | Fiberglass |
| Electrical Rooms | C | 1, 12 | GRC | GALV STL |
| PEA, PC, PEC Room (Areas 62, 69, 71) | W | 4 SST | GRC | GALV STL |
| PAC Control Building (Area 68) | C | 1, 12 | GRC | GALV STL |
| PAC Silo Equipment Room (Area 68) | W<br>H: Class II, Div. 1 (As defined by PAC system supplier) | 4X SST, 9 | PCS | SST |
| Filters (Area 30) | W | 4 SST | GRC | GALV STL |
| Outdoors | W | 4 SST | GRC | GALV STL |
| Notes:<br>(1) Outdoor classified areas require dual rating of NEMA 4X and 7. | | | | |

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
   1. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before starting any Work.

2. Determine information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
3. Provide and document interface with, modifications to, upgrades, or replacement of existing circuits, power systems, controls, and equipment.

## 3.02 PREPARATION (NOT USED)

## 3.03 INSTALLATION

A. Demolition:
   1. As specified in Technical Sections or as indicated on the Drawings.
   2. Disconnect utilities:
      a. Disconnect electrical equipment.
   3. Remove and dispose of conduit, wire, electrical equipment, controls, etc., associated with the items and/or areas to be demolished as indicated on the Drawings unless otherwise indicated.
   4. Salvage electrical equipment as specified in Section 01738 - Selective Alterations and Demolition.
   5. For each piece of equipment to be removed, remove ancillary components (e.g., instruments, solenoid valves, disconnect switches, etc.).
   6. Conduit:
      a. Where conduit removal, other than associated with equipment to be removed, is indicated on the Drawings:
         1) Remove exposed conduit to the point of encasement or burial.
         2) Cut conduit flush and plug or cap encased or buried conduit.
      b. Where conduits are to remain in place and removal is not indicated on the Drawings:
         1) Cap conduit open ends.
         2) Re-label empty conduits as spare.
   7. Remove wire back to the source for conduits to be removed or abandoned in place.
   8. Provide new nameplates for modified electrical distribution equipment, motor control centers etc., to identify equipment and circuits that are no longer used as spares.
   9. Provide new typewritten schedules for modified panelboards.

B. Equipment:
   1. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings.

C. Provide NEC required working space in front of electrical equipment as if it could be worked on energized.

D. Circuits of different service voltage:
   1. Voltage and service levels:
      a. Medium voltage: Greater than 1.0 kV.
      b. Low voltage:
         1) Power and controls: 120 V to 480 V.
         2) Instrumentation: Less than 50 VDC.
      c. Fiber.

2. Install different service voltage circuits in separate raceways as well as underground manholes and hand holes.
3. Install different service voltage circuits in separate junction boxes and pullboxes or provide physical dividers where boxes can be divided.

E. Conductors shall not pass through equipment they are not terminating in unless indicated on the Drawings or approved by the Engineer.

## 3.04 COMMISSIONING

A. General:
1. As specified in Section 01756 - Commissioning, and Technical Sections.
2. Provide onsite assistance for troubleshooting and correcting electrical issues discovered during commissioning.

## 3.05 FIELD QUALITY CONTROL

A. Workmanship:
1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
   a. Neatly coil and label spare wiring lengths.
   b. Shorten, re-terminate, and re-label excessively used, as well as spare, wire and cable lengths, as directed by the Engineer.

Inspection activities conducted during construction do not satisfy the inspection or testing requirements specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.06 ADJUSTING (NOT USED)

## 3.07 CLEANING

A. General:
1. Clean and vacuum enclosures to remove metal filings, surplus insulation and any visible dirt, dust, or other matter before energization of the equipment or system start-up:
   a. Use of compressors or air blowers for cleaning is not acceptable.
2. Clean luminaries in the areas affected by the construction.

END OF SECTION

SECTION 16052

HAZARDOUS CLASSIFIED AREA CONSTRUCTION

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Executing and completing Work in hazardous and/or classified areas as defined by the NEC, NFPA 820, and as indicated on the Drawings and specified in the Specifications.

### 1.02 REFERENCES

A. Definitions:
   1. For the purposes of these Specifications, the terms “Hazardous” and “Classified” will be considered synonymous.

B. Standards:
   1. National Electrical Manufacturers Association (NEMA).
   2. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
      b. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
   3. Underwriters Laboratories (UL):
      a. 1203 - Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS (NOT USED)

### 1.05 QUALITY ASSURANCE

A. Regulatory requirements:
   1. Wiring in hazardous and/or classified locations shall comply with applicable articles of the NEC.
   2. Except as modified in Articles 500 through 516, all other applicable rules contained in the NEC shall apply to electric equipment and wiring installed in hazardous and/or classified locations.
   3. Devices used in Class II, Division 1 or Division 2 areas shall have visible manufacturer installed nameplates specifically stating the Class, Division, and Group for which the device is approved.
   4. PVC-coated fittings for hazardous locations shall be UL 1203 listed after the coating is applied and have a red metal tag attached to the fitting to signify compliance.

### 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. A list of hazardous areas is specified in Section 16050 - Common Work Results for Electrical.

## 1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduit seals shall be filled prior to the introduction of process or gas to the equipment/area.

# PART 2 PRODUCTS (NOT USED)

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION (NOT USED)

## 3.03 INSTALLATION

A. Conduit installation:
   1. As specified in Section 16130 - Conduits.
   2. Wrench tighten conduit joints to minimize sparking when fault current flows through the conduit system.
   3. Make conduit connections so that there are a minimum of 5 threads fully engaged in the connection.
   4. Flexible conduit:
      a. Class II, Division 1 hazardous areas:
         1) Approved and marked suitable for Class II, Division 1.
         2) Listed for compatibility with the group type atmosphere where used.
      b. Class II, Division 2 areas:
         1) Liquidtight metal conduit with approved fittings.
         2) Dusttight flexible connectors.
      c. Maximum length as specified in Section 16130 - Conduits.

B. Sealing fittings:
   1. Provide an approved seal, no more than 12 inches from the enclosure, for conduits entering an enclosure containing switches, circuit breakers, fuses, relays, resistors, or any other apparatus which may produce arcs, sparks, or high temperatures:
      a. Only dusttight proof unions, couplings, elbows, capped elbows, and conduit bodies similar to “L”, “T”, and “X” may be installed between the sealing fitting and the enclosure.
   2. Provide entire assemblies approved for Class II locations for self-sealing or factory sealed assemblies where the equipment that may produce arcs, sparks, or high temperatures is located in a compartment separate from the

compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other:

a. Seals are required in all conduit connections to the compartment containing splices and must be within 12 inches of the enclosure.

3. Install a conduit seal within 12 inches of the boundary in each conduit run entering or leaving a classified location. No union, coupling, box, or fitting is allowed in the conduit between the sealing fitting and the point at which the conduit leaves the classified location.
4. For underground conduits entering or leaving a classified location or between Class II, Division 1 and Division 2 locations:
   a. Provide a conduit seal at both points where the conduit emerges from the ground:
      1) Place the conduit seal within 18 inches of finished grade.
      2) No union, coupling, box, or fitting is allowed in the conduit system between the seal fitting and the point at which the conduit enters the ground.
5. Separate conductors within the conduit system and seal using an approved packing dam installed to both hold the sealing compound and to maintain the separation between the wires:
   a. Remove the outer jacket of multi-conductor non-shielded cables in the area of the sealing fitting and separate each conductor from the cable and seal individually.
6. Install seals with drains in electrical control stations, low points of conduit, or any place where moisture may condense and accumulate.
7. Install the sealing compound in accordance with the manufacturer’s instructions.

C. Boxes and fittings:
1. Class II, Division 1 areas:
   a. Utilize threaded connections for metallic boxes, fittings, and joints to the conduit system.
2. Class II, Division 2 areas:
   a. Provide approved grounding bushings on conduits entering and exiting metallic boxes to bond the conduits together.

D. Outlet boxes and conduit bodies:
1. Suitable for the conduit system as specified in Section 16130 - Conduits.
2. Class II, Division 2 areas:
   a. Boxes not containing arcing parts:
      1) Material and NEMA ratings as specified in Section 16050 - Common Work Results for Electrical.
      2) Pressed metal boxes are not allowed.
   b. Boxes containing arcing parts:
      1) Rated for Class II, Division 1.

E. Motor connections:
1. Conduit installation in Class II, Division 1 and Class II, Division 2 locations for motors that contain arcing parts, shall be as follows:
   a. First - Conduit.
   b. Second - Dusttight flexible coupling.
   c. Third - Sealing fitting.
   d. Fourth - Dusttight union.

e. Fifth - Connection to the motor terminal box.

2. Wiring connections to motor leads shall be as specified in Section 16150 - Low Voltage Wire Connections.

F. Bond the non-current-carrying metal parts of equipment, raceways and other enclosures as required by the NEC to ensure electrical continuity.

## 3.04 FIELD QUALITY CONTROL

A. Obtain inspection and approval before and after each seal is poured.

END OF SECTION

# SECTION 16060

# GROUNDING AND BONDING

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Grounding materials and requirements.

### 1.02 REFERENCES

A. ASTM International (ASTM):
   1. B3 - Standard Specification for Soft or Annealed Copper Wire.
   2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

D. Underwriters Laboratories, Inc. (UL):
   1. 467 - Ground and Bonding Equipment.

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.

### 1.05 QUALITY ASSURANCE

A. Grounding components and materials shall be UL listed and labeled.

### 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

### 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

### 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Ground equipment and raceway systems so that the completed installation is in accordance with applicable code requirements.

B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:
   1. Grounding electrodes.
   2. Bonding jumpers.
   3. Ground connections.

## 2.03 MANUFACTURERS

A. Compression connectors: One of the following or equal:
   1. ABB.
   2. Burndy.
   3. Erico.
   4. Harger.
   5. Panduit.

B. Ground rods: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Nehring.

C. Ground cable: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Nehring.
   4. Southwire.

D. Precast ground well boxes: One of the following or equal:
   1. Brooks Products, 3-RT Valve Box.
   2. Christy Concrete Products, G12 Valve Box.

## 2.04 MATERIALS

A. Ground rod:
   1. Minimum: 3/4-inch diameter, 10-feet long.
   2. Uniform 10 mil covering of electrolytic copper metallically bonded to a rigid steel core:
      a. Copper-to-steel bond shall be corrosion resistant.

3. In accordance with UL 467.
4. Sectional type joined by threaded copper alloy couplings.
5. Fit the top of the rod with a threaded coupling and steel-driving stud.

B. Ground cable:
   1. Requirements:
      a. Soft drawn (annealed).
      b. Concentric lay, coarse stranded in accordance with ASTM B8.
      c. Bare copper in accordance with ASTM B3.
   2. Size is as indicated on the Drawings, but not less than required by the NEC. Use the following type of wire unless otherwise indicated on the Drawings:
      a. Size #6 AWG and smaller; solid conductor.
      b. Size #4 AWG and larger; stranded conductor.

C. Compression connectors:
   1. Manufactured of high copper alloy specifically for the particular grounding application.
   2. Suitable for direct burial in earth and concrete.
   3. Identifying compression die number inscription to be impressed on compression fitting.

D. Grounding electrode conductors:
   1. Minimum size in accordance with the NEC.

E. Main bonding jumpers and bonding jumpers:
   1. Minimum size in accordance with the NEC.

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS (NOT USED)

## 2.08 ACCESSORIES

A. Precast ground well boxes:
   1. Minimum 10-inch interior diameter.
   2. Traffic-rated cast iron cover.
   3. Permanent “GROUND” marking on cover.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.

B. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:
   1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.

C. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:
   1. Individually bond these raceways to the ground bus in the equipment.

D. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.

E. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.

F. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.

G. Duct bank ground system:
   1. Provide a bare copper grounding conductor the entire length of each duct bank, embedded in the concrete of the duct bank as indicated on the Drawings and specified in the Specifications.
   2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.

H. Grounding at service (600 V or Less):
   1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.

I. Ground connections:
   1. Connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using compression type grounding connectors as indicated on the Drawings, UL listed, and labeled for the application.
   2. Make ground connections in accordance with the manufacturer’s instructions.

3. Do not conceal or cover any ground connections until the Engineer or authorized representative has established and provided written confirmation that every grounding connection is as indicated on the Drawings and specified in the Specifications.

J. Grounding electrode system:
   1. Ground ring:
      a. Provide trenching and materials necessary to install the ground ring as indicated on the Drawings.
      b. Ground ring conductor shall be in direct contact with the earth, or where embedded, concrete, of the size as indicated on the Drawings.
      c. Minimum burial depth 36 inches or as indicated on the Drawings.
      d. Re-compact disturbed soils to original density in 6-inch lifts.
   2. Ground rods:
      a. Locations as indicated on the Drawings.
      b. Length of rods forming an individual ground array shall be equal in length.
      c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.
      d. Pre-crimp ground rods, as recommended by the manufacturer, before crimping connector to ground rod.

   3. Metal underground water pipe:
      a. Bond metal underground domestic water pipe to grounding electrode system.
      b. Cathodically protected systems: Bond in accordance with cathodic protection system design requirements.
   4. Metal frame of building or structure:
      a. Bond metal frame of building or structure to grounding electrode system.
   5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.
   6. Where grounding conductors are exposed and subject to physical damage, install in Schedule 80 PVC conduit for protection.
   7. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.

K. Shield grounding:
   1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
   2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable run.
   3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
   4. Terminate the signal cable shield on a dedicated grounding terminal block.

L. Where indicated on the Drawings, install ground rods in precast ground wells.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL

A. Ground system resistance (electrode to ground) of the completed installation, as determined by tests, shall be:
   1. 5 ohms or less for industrial systems.
   2. 1 ohm or less for electrical buildings.

B. Measure grounding electrode system resistance to ground in accordance with IEEE 81.

## 3.06 ADJUSTING

A. Under the direction of the Engineer, add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurement meets the specified resistance requirements:
   1. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

END OF SECTION

## SECTION 16070

## HANGERS AND SUPPORTS

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Mounting and supporting electrical equipment and components.

## 1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   4. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Anchor: Elements (including hardware) connecting hangers and supports to the structure.
   2. Hardware: Nuts, bolts, straps, clamps, threaded rod, etc.
   3. Supports: Preformed channel or other structural member on which the electrical equipment or raceway is mounted.

## 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Supports:
      a. Materials.
      b. Geometry.

c. Manufacturer.
2. Hardware:
   a. Materials.
   b. Manufacturer.

C. Shop Drawings:
1. Dimensioned and scalable Shop Drawings of hangers and supports for distribution systems and equipment.
2. Complete details for:
   a. Member sizes and arrangement in hangers and support assemblies.
   b. Connections between members in hangers and support assemblies.
   c. Anchoring hangers and supports to structures.
   d. Bracing for hangers and supports and anchoring of bracing to structures.
3. Include data on connections, attachment hardware and construction to demonstrate that hangers and supports will satisfy the design loading, bracing, and anchoring criteria.

D. Delegated Design Submittals:
1. Hangers and supports - General:
   a. Locations and conditions:
      1) Hangers and supports inside structures.
      2) Hangers and supports that resist cable pulling/rigging loads.
   b. Required Submittals: Details with supporting calculations for:
      1) Support member arrangement, sizes, and connections.
      2) Bracing to resist cable pulling/rigging loads.
      3) Connections of hangers, supports, and bracing to the structure.
      4) Connections between supports and the equipment or raceway(s) thereon.
2. Hangers and supports - Exterior and seismic conditions:
   a. Locations and conditions:
      1) Hangers and supports at structures designated as Seismic Design Category (SDC) C, D, E, or F in Section 01850 - Design Criteria.
      2) Hangers and supports for outdoor installations.
   b. Required Submittals:
      1) Interior: Bracing to resist seismic design loads specified in Section 01850 - Design Criteria.
      2) Exterior: Bracing to resist seismic, wind, and other environmental loads specified in Section 01850 - Design Criteria.
3. Hangers and supports anchored to concrete and masonry:
   a. Locations and conditions:
      1) Post-installed mechanical anchors in tension.
      2) Post-installed adhesive-bonded all-thread rods in tension.
   b. Required Submittals:
      1) Calculations demonstrating that anchors have a demand/capacity ratio (D/C) not greater than the following when anchor capacity is adjusted for moisture conditions, anchor spacing and edge distances, and sustained loading conditions present at the location of installation.
         a) Post-installed mechanical anchors maximum: 85 percent.
         b) Post-installed adhesive-bonded anchors maximum: 75 percent.

## 1.06 QUALITY ASSURANCE (NOT USED)

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Mount raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated supports unless otherwise indicated on the Drawings.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Hangers and supports individually and as a system shall resist weights and code-required forces without deflections and deformations that would damage the supporting elements, the raceway or equipment supported, or the surrounding construction.
   1. Provide the necessary sway bracing to keep support structures from swaying due to lateral forces including wire and cable pulling forces.
   2. Lateral deflection at top of slab mounted supports shall not exceed support height divided by 240, unless otherwise approved by the Engineer.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. Preformed channel:
      a. Cooper B-line.
      b. Power-Strut.
      c. Robroy.
      d. Tyco.
      e. Unistrut.
   2. Nonmetallic cable rack:
      a. Hubbell.
      b. Underground Devices Inc.
      c. Unistrut.

## 2.04 MATERIALS

A. Hot dip galvanized steel:
   1. Supports:
      a. In accordance with ASTM A123 or A153.
      b. Minimum zinc coating thickness of 2.5 mils.

c. Nominal dimensions: 1-5/8 inch by 1-5/8 inch.
2. Hardware:
   a. Electro-galvanized.
   b. In accordance with ASTM A153.

B. Stainless steel:
1. Supports:
   a. In accordance with ASTM A240.
   b. ANSI Type 316 material.
   c. Nominal dimensions: 1-5/8 inch by 1-5/8 inch.
2. Hardware:
   a. ANSI Type 316 material.

C. Fiberglass:
1. Supports:
   a. Vinyl ester.
   b. Nominal dimensions: 1-5/8 inch by 1-5/8 inch.
   c. Flame spread rating of 25 or less in accordance with ASTM E84.
   d. Tested in accordance with ASTM D635.
2. Hardware:
   a. Polypropylene.
   b. Thermal plastic elastomer.
   c. Fiberglass reinforced plastic.

D. Non-metallic cable rack:
1. Consists of stanchions and cable support arms.
2. Stanchions:
   a. 50 percent glass reinforced nylon or other non-metallic material.
   b. Capable of supporting multiple arms.
   c. Recessed bolt mounting holes.
   d. Length as required.
3. Arms:
   a. 50 percent glass reinforced nylon or other non-metallic material.
   b. Size the arms based on the length and weight of the cable to be supported.
4. Stainless steel mounting hardware.

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS

A. Fabricated metal supports: As specified in Section 05500 - Metal Fabrications.

## 2.08 ACCESSORIES

A. Anchors:
1. As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES

A. Paint and finish structures as specified in Section 09960 - High-Performance Coatings.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Use materials appropriate for the area as specified in Section 16050 - Common Work Results for Electrical.

B. General:
   1. Refer to the Drawings for details. Equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.
   2. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.

C. Corrosion protection:
   1. Isolate dissimilar metals, except where required for electrical continuity.
      a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.

D. Anchoring methods:
   1. Solid concrete:
      a. Anchor bolts, anchor rods or post-installed anchors as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   2. Metal surfaces: Machine screws or bolts.
   3. Hollow masonry units:
      a. Post installed anchors as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   4. Wood and metal studs:
      a. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.

E. Recoat or seal drilled holes, cut or scratched surfaces or with products recommended by the manufacturer.

F. Group raceway and position on racks to minimize crossovers.

G. Non-metallic cable rack:
1. Install the non-metallic cable rack in accordance with the manufacturer's recommendations.
2. Provide at least 2 stanchions and 2 arms at each installation.
3. Mount the cable rack so that the supported cable does not interfere with access to manhole or handhole and so that the supported cable does not lie on the floor.
4. Do not exceed the cable manufacturer's minimum bending radius.
5. Use nylon cable ties to secure the cable to the supports.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

## SECTION 16075

## IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Identification of electrical equipment, devices and components.
   2. Material, manufacturing and installation requirements for identification devices.

### 1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Occupational Safety and Health Administration (OSHA).

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Nameplates:
      a. Color.
      b. Size:
         1) Outside dimensions.
         2) Lettering.
      c. Material.
      d. Mounting means.
   2. Nameplate schedule:
      a. Show exact wording for each nameplate.
      b. Include nameplate and letter sizes.
   3. Wire numbers:
      a. Manufacturer’s catalog data for wire labels and label printer.

C. Record documents:
   1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

### 1.05 QUALITY ASSURANCE (NOT USED)

### 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

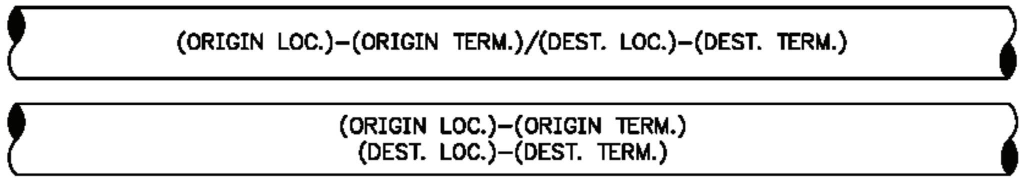
## 2.01 GENERAL

A. Nameplates:
   1. Provide for control panel operator devices (e.g., pushbuttons, selector switches, pilot lights, etc.):
      a. Same material and same color and appearance as the device nameplates to achieve an aesthetically consistent and coordinated system.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Nameplates:
   1. Provide for each piece of electrical equipment, device, control panel, and control panel components.
   2. Identical style, color, and material throughout the facility.
   3. Device nameplates information:
      a. Equipment tag number as indicated on the Drawings.

B. Wire numbers:
   1. Coordinate the wire numbering system with vendors of equipment so that every field wire has a unique number associated with it for the entire system:
      a. Correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
      b. Correspond to the terminal block number to which they are attached in the control panel.
      c. Internal panel wires on a common terminal shall have the same wire number.
      d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. Multi-conductor and instrumentation cables shall be identified at pull points as described above:
         1) Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers specified in Section 16130 - Conduits.
   2. Provide the following wiring numbering schemes throughout the project for field wires between process control module (PCM), vendor control panels (VCP), motor control centers (MCC), field starters, field instruments, etc.




OR:

Where:

ORIGIN LOC. = Designation for originating panel or device

ORIGIN TERM. = Terminal designation at originating panel or device

DEST. LOC. = Designation for destination panel or device

DEST. TERM. = Terminal designation at destination panel or device or PLC

3. I/O address at destination panel:
   a. Identify equipment and field instruments as the origin.
   b. PCMs are always identified as the destination.
   c. Location is the panel designation for VCP, LCP, or PCM. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
   d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.
   e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g., T1, T2, T3, etc.).
   f. Terminal designations at PCMs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: The following PLC I/O numbering scheme is typical for Allen-Bradley. The numbering scheme should be modified to match that of the actual PLC manufacturer used for the Project):

      Discrete Point: W:X:Y/Z.

      Analog Point: W:X:Y.Z.

      Where:

      W = I for input, O for output.

      X = PLC number (1, 2, 3…)

      Y = Slot number (01, 02, 03…)

      Z = Terminal number (00, 01, 02…) for a discrete point or a word number for an analog point (1, 2, 3…)

   g. Terminal designations at PCMs where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (e.g., C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with "A" (e.g., C0010A).

4. **Case 1**: Vendor control panel (VCP) to process control module (PCM):

   Field wire number/label: A-B/C-D:

   A = Vendor control panel number without hyphen (VCP#)

   B = Terminal number within VCP (manufacturer's or vendor's standard terminal number)

   C = Process control module number without hyphen (PCM#)

   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

   Examples:

   VCP#-10/PCM#-I: 1:01/01

   VCP#-10/PCM#-O: 1:10/07

   VCP#-10/PCM#-C0100

5. **Case 2**: Field instrument to process control module (PCM):

   Field wire number/label: E-F/C-D:

   C = Process control module number without hyphen (PCM#)

   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

   E = Field mounted instrument tag and loop numbers without hyphen (EDV#)

   F = Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma

   Examples:

   TIT#-2,3/PCM#-I: 1:01.1

   TSH#-1/PCM#-I: 2:01/00

6. **Case 3**: Motor control center (MCC) to process control module (PCM):

   Field wire number/label: G-B/C-D:

   B = Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number)

   C = Process control module without hyphen (PCM#)

   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

   G = Actual starter designation in the motor control center without hyphen (MMS#)

   Examples:

   MMS#-10/PCM#-I: 1:01/01

MMS#-10/PCM#-O: 1:10/07

MMS#-10/PCM#-C0100

7. **Case 4**: Motor control center (MCC) to vendor control panel (VCP):

   Field wire number/label: G-B/A-B:

   A = Vendor control panel number without hyphen (VCP#)

   B = Terminal number within motor control center or vendor control panel (manufacturer's or vendors standard terminal number)

   G = Actual starter designation in the motor control center without hyphen (MMS#)

   Example:

   MMS#-X2/VCP#-10

8. **Case 5**: Motor leads to a motor control center (MCC):

   Field wire number/label: H-I/G-B:

   B = Terminal number within motor control center (manufacturer's standard terminal number)

   G = Actual starter designation in the motor control center without hyphen (MMS#)

   H = Equipment tag and loop number without hyphen (PMP#)

   I = Motor manufacturer's standard motor lead identification (e.g., T1, T2, T3, etc.)

   Example:

   PMP-#-T3/MMS#-T3

9. **Case 6**: Remote or separately mounted starter or variable frequency drive (VFD) to process control module (PCM):

   Field wire number/label: J-B/C-D:

   B = Terminal number within starter or variable frequency drive (manufacturer's standard terminal number)

   C = Process control module number without hyphen (VCP#)

   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

   J = Starter or variable frequency drive tag and loop number without hyphen (MMS#)

   Examples:

   MMS#-10/PCM#-I: 1:01/01

   MMS#-10/PCM#-O: 2: 10/07

   MMS#-10/PCM#-C0010

10. Identify spare conductors as required for other field wires with an “S” prefix:

    Example:

    S MMS#-10/PCM#-C011

## 2.03 MANUFACTURERS

A. Nameplates and signs:
   1. One of the following or equal:
      a. Brady.
      b. Seton.

B. Conductor and cable markers:
   1. Heat-shrinkable tubing:
      a. One of the following or equal:
         1) Brady.
         2) Kroy.
         3) Panduit.
         4) Raychem.

C. Conduit and raceway markers:
   1. Non-metallic: One of the following or equal:
      a. Almetek: Mini Tags.
      b. Lapp Group: Maxi System.

D. Medium voltage raceway voltage labels:
   1. One of the following or equal:
      a. Brady.
      b. Seton.

## 2.04 MATERIALS

A. Nameplates:
   1. Colors:
      a. Warning: White-center, red face.
      b. Other: Black-center, white face.
   2. Laminated plastic engraving stock:
      a. 3/32-inch-thick material.
      b. 2-ply.
   3. With chamfered edges.
   4. Lettering:
      a. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:
      b. Minimum letter height: 1/8-inch.

B. Signs:
   1. Automatic equipment and high voltage signs:
      a. Suitable for exterior use.
      b. In accordance with OSHA regulations.

C. Conductor and cable markers:
  1. Lettering:
    a. Machine printed black characters on white tubing.
    b. Minimum letter height: 10-point type or larger.

D. Conduit and raceway markers:
  1. Non-metallic:
    a. UV resistant holder and letters.
    b. Black letters on yellow background.
    c. Minimum letter height: 1/4-inch.
    d. Adhesive labels are not acceptable.

E. Medium voltage circuit raceway labels:
  1. Vinyl plastic.
  2. Minimum letter height: 1-inch.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. Nameplates:
  1. Attach to equipment with rivets, bolts, or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
  2. Provide for each disconnecting means with the following:
    a. Equipment served, voltage, and fuse size as required.
    b. Identification of the circuit source that supplies the disconnecting means.
  3. On NEMA Type 4, NEMA Type 4X, or NEMA Type 7 enclosures, use epoxy-based cement to attach nameplates.
  4. Aligned and level or plumb to within 1/64 inch over the entire length:
    a. Misaligned or crooked nameplates shall be remounted or provide new enclosures at the discretion of the Engineer.

B. Conductor and cable markers:
  1. Apply before termination.
  2. Heat-shrinkable tubing:
    a. Shrunk using a heat gun that produces low temperature heated air.
    b. Tight on the wire after it has been heated.
    c. Characters shall face the open panel and shall read from left to right or top to bottom.
    d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

C. Conduit markers:
1. Furnish and install markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:
   a. Markings shall match the conduit schedule.
2. Mark conduits at the following locations:
   a. Each end of conduits that are greater than 10 feet in length.
   b. The middle of conduits that are 10 feet or less in length.
   c. Where the conduit penetrates a wall or structure.
   d. Where the conduit emerges from the ground, slab, etc.
3. Mark conduits after the conduits have been fully painted.
4. Position conduit markers so that they are easily read from the floor.
5. Attach non-metallic conduit markers with nylon cable ties:
   a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
6. Mark conduits before construction review by the Engineer for punch list purposes.
7. Label intrinsically safe conduits in accordance with the requirements of the NEC.

D. Medium voltage raceway labels:
1. Apply at 50-foot intervals stating the voltage level contained within the raceway.

E. Signs and labeling:
1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
   a. Fasten warning signs with round head stainless steel screws or bolts.
   b. Locate and mount in a manner to be clearly legible to operations personnel.
2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc., where the voltage exceeds 600 volts.
3. Furnish and install warning signs on equipment that has more than one source of power.
   a. Warning signs to identify every panel and circuit number of the disconnecting means of external power sources.
4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking.
   a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.
5. Label service entrance equipment, switchgear, switchboards, MCCs, panelboards, and transfer switches with the available short circuit current, equipment label, and date of application in accordance with NEC. Coordinate with Section 16305 - Electrical System Studies for available fault current data.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

## 3.05 FIELD QUALITY CONTROL

A. Replace any nameplates, signs, conductor markers, cable markers, or raceway labels that in the sole opinion of the Engineer do not meet the Engineer’s aesthetic requirements.

END OF SECTION

## SECTION 16123

## 600-VOLT OR LESS WIRES AND CABLES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. 600-volt class or less wire and cable.

### 1.02 REFERENCES

A. Abbreviations:
   1. AWG: American wire gauge.
   2. BCCS: Bare copper-covered steel.
   3. CPE: Chlorinated polyethylene.
   4. FHDPE: Foam high-density polyethylene.
   5. FPE: Foam polyethylene.
   6. OD: Outside diameter.
   7. PVC: Polyvinyl chloride.
   8. XHHW: Cross-linked high heat water resistant insulated wire.

B. Standards:
   1. ASTM International (ASTM):
      a. B3 - Standard Specification for Soft or Annealed Copper Wire.
      b. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. CSA International (CSA).
   3. Insulated Cable Engineer's Association (ICEA):
      a. S-90-661 - Individually Unshielded Twisted Pair Indoor Cables for Use in Communication Wiring Systems.
   4. National Electrical Code (NEC).
   5. National Electrical Manufacturers Association /Insulated Cable Engineers Association (NEMA/ICEA):
      a. NEMA WC 66/ICEA S-116-732 - Standard for Category 6 and 6A, 100 Ohm, Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in LAN Communication Wiring Systems.
      b. NEMA WC 70/ICEA S-95-658-1999 - Standard for Power Cables Rated 2,000 Volts or Less for the Distribution of Electrical Energy.
   6. National Fire Protection Association (NFPA):
      a. 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
   7. Telecommunications Industry Association (TIA):
      a. 568.2-D - Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
      b. 569-B - Commercial Building Standards for Telecommunications Pathways and Spaces.

8. Underwriter's Laboratories Inc., (UL):
    a. 44 - Standard for Thermoset-Insulated Wires and Cables.
    b. 1277 - Electrical Power and Control Tray Cables with Optional-Fiber Members.
    c. 1666 - Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
    d. 2225 - Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

## 1.03 DELEGATED DESIGN (NOT USED)

## 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
  1. Manufacturer of wire and cable.
  2. Insulation:
    a. Type.
    b. Voltage class.
  3. AWG size.
  4. Conductor material.
  5. Pulling compounds.

C. Shop Drawings:
  1. Show splice locations.
    a. For each proposed splice location provide written justification describing why the splice is necessary.

D. Test reports:
  1. Submit test reports for meg-ohm tests.

E. Calculations:
  1. Submit cable pulling calculations to the Engineer for review and comment for cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
    a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
    b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

F. Cable lengths:
  1. Submit installed cable lengths using a conduit measuring tape for 3-phase circuits.
  2. Submit installed lengths of cable for the following single-phase circuits:
    a. Circuits feeding single-phase transformers.
    b. Circuits feeding single-phase panelboards.

## 1.05 QUALITY ASSURANCE

A. Wires and cables shall be UL listed and labeled.

## 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. General site and project conditions:
   1. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Color-coding:
   1. Color-coding shall be consistent throughout the facility.
   2. The following color code shall be followed for 240/120 volt and 208/120-volt systems:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Single phase system: Black for 1 hot leg, red for the other.
      e. Neutral: White.
      f. High phase or wild leg: Orange.
      g. Equipment ground: Green.
   3. The following color code shall be followed for 480/277-volt systems:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Gray.
      e. Equipment ground: Green.
   4. The following color code shall be followed for 120 VAC control wiring:
      a. Power: Red.
      b. Neutral: White.
   5. The following color code shall be followed for general purpose DC control circuits:
      a. Ground conductors: Black.
      b. Ungrounded conductors: Red.
   6. The following color code shall be followed for general purpose control wiring inside a control cabinet:
      a. Digital Inputs: 16 AWG Yellow.
      b. Digital Outputs: 16 AWG Orange.
      c. Analog signals 18 AWG shielded (+) White or Red.

d. Analog signals 18 AWG shielded (-) Black.
e. DC power supply 16 AWG MTW (+) Red / (-) Blue.

7. Switch legs shall be violet. 3-way switch runners shall be Pink.
8. Wires in intrinsically safe circuits shall be Light blue.
9. Wire colors shall be implemented in the following methods:
   a. Wires manufactured of the desired color.
   b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
      1) Colored tape shall be wrapped to overlap half of the width of the tape.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Furnish and install the complete wire and cable system.

## 2.03 MANUFACTURERS

A. One of the following, or equal:
1. 600-volt class wire and cable:
   a. Okonite Co.
   b. Prysmian General Cable.
   c. Service Wire.
   d. Southwire Co.
2. 600-volt VFD cable:
   a. Prysmian General Cable.
   b. Service Wire.
   c. Southwire Co.
3. Instrumentation class wire and cable:
   a. Alpha Wire Co.
   b. Belden CDT.
   c. Okonite Co.
   d. Prysmian General Cable.
   e. Rockbestos Surprenant Cable Corp.
4. Network cables:
   a. Belden.
   b. CommScope.
   c. General Cable.

## 2.04 MATERIALS

A. Conductors:
1. Copper in accordance with ASTM B3.

## 2.05 MANUFACTURED UNITS

A. General:
1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
2. Permanently mark each wire and cable with the following at 24-inch intervals:
   a. AWG size.
   b. Voltage rating.
   c. Insulation type.

d. UL symbol.
e. Month and year of manufacture.
f. Manufacturer's name.

3. Identify and mark wire and cable as specified in Section 16075 - Identification for Electrical Systems:
    a. Use integral color insulation for #2 AWG and smaller wire.
    b. Wrap colored tape around cable larger than #2 AWG.

B. 600-volt class wire and cable:
1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Conduit Schedules:
    a. When not indicated on the Drawings, size wire as follows:
        1) In accordance with the NEC:
            a) Use 75-degree Celsius ampacity ratings.
            b) Ampacity rating after derating factors, equal to or greater than rating of the overcurrent device.
        2) Provide #12 AWG minimum for power conductors.
        3) Provide #14 AWG minimum for control conductors.
2. Provide Class B stranding in accordance with ASTM B8:
    a. Provide Class C stranding where extra flexibility is required.
3. Insulation:
    a. XHHW-2.
    b. 90-degree Celsius rating.

C. 600-volt VFD cables:
1. Conductor:
    a. Provide Class B stranding in accordance with ASTM B3 and B8.
    b. Copper conductor.
2. Insulation:
    a. Cross-linked Polyethylene, XLPE.
    b. 90-degree Celsius rating.
    c. UL 44 Type RHH/RHW-2 or XHHW-2.
    d. 2,000 volts.
3. Ground:
    a. Provide Class B compressed stranded bare copper in accordance with ASTM B3 and B8.
    b. 3 symmetrically placed bare copper conductors in direct contact with shield.
    c. Equivalent ground size 50 percent of the phase conductor size.
4. Filler:
    a. Cable sizes 8 and 6 use polypropylene filler.
    b. Other cable sizes use paper filler.
5. Metallic shield:
    a. Overall 5 mil bare copper tape shield with 50 percent overlap.
6. Outer jacket:
    a. UL 1277 Type PVC.
7. Cable tray rated, UL Type TC-ER.

D. Instrumentation class cable:
1. Type TC.
2. Suitable for use in wet locations.

3. Voltage rating: 600 volts.
4. Temperature rating:
    a. 90 degree Celsius rating in dry locations.
    b. 75 degree Celsius rating in wet locations.
5. Conductors:
    a. Insulation:
        1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
    b. #16 AWG stranded and tinned.
    c. Color code: ICEA Method 1:
        1) Pair: Black and white.
        2) Triad: Black, white and red.
        3) Multiple pairs or triads:
            a) Color-coded and numbered.
6. Drain wire:
    a. #18 AWG.
    b. Stranded, tinned.
7. Jacket:
    a. Flame retardant, moisture and sunlight resistant PVC.
    b. Ripcord laid longitudinally under jacket to facilitate removal.
8. Shielding:
    a. Individual pair/triad:
        1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
    b. Multiple pair or triad shielding:
        1) Group shield: Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
        2) Completely isolate group shields from each other.
        3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
    c. Shielding to be in contact with the drain wire.

E. Network cables:
1. Copper Ethernet cable:
    a. Provide copper Ethernet cable types as indicated on the Drawings and Specifications.
    b. General requirements:
        1) Cables shall meet the standards set by TIA-568.2-D and verified by third-party testing laboratory.
        2) Conductors:
            a) 4 balanced twisted pairs.
                (1) #22 to #24 AWG thermoplastic insulated solid copper conductors enclosed by a thermoplastic jacket. Copper clad aluminum is not allowed.
        3) Insulation:
            a) Non-Plenum: Polyolefin.
            b) Plenum: Fluoropolymer.
        4) Color coded per T568B.
        5) Outer jacket with ripcord.

6) Shielding:
   a) Provide F/UTP cables with drain wire for cables inside any equipment or enclosure with 480 VAC and above, outdoor installations, and where indicated on the Drawings.
7) Voltage rating:
   a) At a minimum provide 300 VAC rated jacket.
   b) 600 VAC rated jacket when cables are inside equipment or enclosures that contain 480 VAC power.
8) Approvals and listings:
   a) Meets any necessary NEC and NFPA requirements for each application.
   b) Riser applications: CMR in accordance with UL 1666.
   c) Plenum applications: CMP in accordance with NFPA 262.
9) Certification:
   a) Provide Category 5e cables with ICEA S-90-661 certification.
   b) Provide Category 6 cables with NEMA WC 66/ICEA S-116-732 certification.
   c) Provide Category 6A cables with NEMA WC 66/ICEA S-116-732 certification.

**2.06 EQUIPMENT (NOT USED)**

**2.07 COMPONENTS (NOT USED)**

**2.08 ACCESSORIES**

A. Wire ties:
   1. One of the following, or equal:
      a. Panduit, cable ties.
      b. T&B, “Ty-Rap” cable ties.

B. Wire markers:
   1. As specified in Section 16075 - Identification for Electrical Systems.

**2.09 FABRICATION (NOT USED)**

**2.10 FINISHES (NOT USED)**

**2.11 SOURCE QUALITY CONTROL**

A. Assembly and testing of cable shall comply with the applicable requirements of NEMA WC 70/ICEA S-95-658-1999.

B. Test Type XHHW-2 in accordance with the requirements of UL 44.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. Install conductors only after the conduit installation is complete, and enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
   1. Install wires only in approved raceways.
   2. Do not install wire:
      a. In incomplete conduit runs.
      b. Until after the concrete work and plastering is completed.

B. Properly coat wires and cables with pulling compound before pulling into conduits:
   1. For #4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
      a. Ideal Products.
      b. Polywater Products.
      c. 3M Products.
      d. Greenlee Products.
      e. Or equal, as recommended by cable manufacturer.
      f. Do not use oil, grease, or similar substances.

C. Cable pulling:
   1. Prevent mechanical damage to conductors during installation.
   2. For cables #1 AWG and smaller, install cables by hand.
   3. For cables larger than #1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
   4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
   5. Ensure cable pulling crews have calculations and cable pulling limitations while pulling cable.
   6. Make splices or add a junction box or pullbox where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer’s recommendation for the specified cable size:
      a. Make splices in manholes or pull boxes only.
      b. Leave sufficient slack to make proper connections.

D. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer’s recommendations.

E. Install and terminate wire in accordance with manufacturer's recommendations.

F. Neatly arrange and lace conductors in switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
   1. Do not lace wires in gutter or panel channel.

2. Install wire ties with a flush cutting wire tie installation tool:
   a. Use a tool with an adjustable tension setting.
3. Do not leave sharp edges on wire ties.

G. Terminate stranded conductors on equipment box lugs such that conductor strands are confined within the lug:
   1. Use ring type lugs if box lugs are not available on the equipment.

H. Lighting circuits:
   1. Each circuit shall have a dedicated neutral.

I. Splices:
   1. Provide continuous circuits from origin to termination whenever possible:
      a. Obtain Engineer's approval prior to making any splices.
   2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.
   3. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths:
      a. Splice box NEMA rating requirements as specified in Section 16050 - Common Work Results for Electrical.
      b. Make splices in labeled junction boxes for power conductors.
      c. Make splices for control and instrument conductors in terminal boxes:
         1) Provide terminal boards with setscrew pressure connectors, with spade or ring lug connectors.
   4. Power and control conductors routed in common raceways may be spliced in common junction boxes.
   5. Clearly label junction and terminal boxes containing splices with the word "SPLICE LOCATED WITHIN".
   6. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.
   7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
      a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are listed for submersible applications.
   8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made waterproof using:
      a. A heat shrink insulating system listed for submersible applications.
      b. Or an epoxy resin splicing kit.

J. Apply wire markers to wires at each end after being installed in the conduit and before meg-ohm testing and termination.

K. Instrumentation class cable:
   1. Install instrumentation class cables in separate raceway systems from power cables:
      a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
      b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
   2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.

3. Shield grounding requirements as specified in Section 16060 - Grounding and Bonding.

L. Copper Ethernet cables:
   1. In accordance with TIA-568.2-D.
   2. Pathways:
      a. For initial installation, the maximum fill capacity for pathways (i.e., conduit, raceways, trays, baskets) is 40 percent. The maximum fill capacity of 60 percent is allowed to accommodate future additions after initial installation.
      b. Conduit should be run in the most direct route possible with no more than two 90-degree bends between pull boxes and serve no more than 3 outlet boxes.
   3. Cable bend radius:
      a. Proper cable bend radius control must be maintained throughout the pathways. Bend radius needs to be at a minimum 10 times the cable diameter.
   4. Cable pulling:
      a. Provide cable pulling swivel system to prevent winding and tangling of rope and cables during pull.
      b. Maximum pulling tension is not to exceed manufacturer recommendations. Cable installation should not in any way deform the cable jacket.
      c. 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.
   5. Cable management:
      a. Organize and manage cables for quick and easy moves, adds and changes.
   6. Cable termination:
      a. Install equipment outlet connector hardware (e.g., RJ45, M12, etc.), and connect to field equipment outlet (e.g., instrument, VFD, actuator, etc.).
      b. Use shielded connectors as required by the installation.
      c. Coordinate cable termination at copper patch panels with ICSC and General Contractor.
   7. Testing:
      a. Copper Ethernet cable testing requirements as specified in Section 16950 - Field Electrical Acceptance Tests.
   8. Separation from EMI sources:
      a. Comply with TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
      b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
         1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
         2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
         3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
    2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.

M. Signal cable:
    1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.

N. Wiring allowances:
    1. Equipment locations may vary slightly from the Drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
    2. Locations for pull boxes, manholes, and duct banks may vary slightly from the Drawings. Include an allowance for necessary conductors and related materials to provide conductors to pull boxes, manholes and duct banks within 20-linear feet of locations indicated on the Drawings.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
    1. As specified in Section 16950 - Field Electrical Acceptance Tests.

END OF SECTION

## SECTION 16124

## MEDIUM VOLTAGE CABLES

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Medium voltage cables rated 5,000 through 35,000 volts.

## 1.02 REFERENCES

A. Definitions:
   1. Definitions of terms and other electrical considerations as set forth by:
      a. ICEA.
      b. ASTM.

B. Standards:
   1. Association of Edison Illuminating Companies (AEIC):
      a. CS8 - Specification for Extruded Dielectric, Shielded Power Cables Rated 5 through 46 kV.
   2. ASTM International (ASTM):
      a. B3 - Standard Specification for Soft or Annealed Copper Wire.
      b. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
      c. B496 - Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
   3. Insulated Cable Engineers Association (ICEA):
      a. S-93-639 - 5-46 kV Shielded Power Cable for Use in the Distribution of Electrical Energy.
      b. S-94-649 - Standard for Concentric Neutral Cables Rated 5 Through 46 kV.
      c. S-97-682 - Standard for Utility Shielded Power Cables Rated 5 Through 46 kV.
   4. National Electrical Code (NEC).
   5. National Electrical Manufacturers Association (NEMA).
   6. Underwriter’s Laboratories (UL):
      a. 1072 - Standard for Safety for Medium-Voltage Power Cables.

## 1.03 DELEGATED DESIGN (NOT USED)

## 1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Voltage class.

3. Conductor:
    a. Size.
    b. Material.
    c. Stranding.
4. Insulation:
    a. Type.
    b. Level.
5. Shielding.
6. Temperature rating.
7. Jacket material.

C. Shop drawings:
1. Show splice locations.
2. Provide details on the pull plan:
    a. Show splice locations, if applicable.
    b. Cable layout locations, if applicable.
    c. Actions for protecting cables at each phase of the installation.

D. Calculations:
1. Submit cable pulling calculations to the Engineer for review and comment showing that the maximum cable tension and sidewall pressure will not exceed Manufacturer recommended values:
    a. Provide a table showing the manufacturer’s recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
        1) Increase the coefficient of friction for the calculation until either maximum cable tension or maximum sidewall pressure is reached. If maximum sidewall pressure is reached before maximum tension, the tension at which the maximum sidewall pressure is reached will be the maximum pull tension for the pull.
2. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

E. Qualifications:
1. Submit qualifications for the individual(s) that will be performing medium voltage cable splices and terminations at least 30 calendar days before splicing or terminating.
2. Documentation that the individual has received training by splice/termination Manufacturer or an independent testing laboratory.
3. A statement of the number of years in which the individual has been splicing and terminating medium voltage cable.

F. Test reports:
1. Submit AC withstand partial discharge (corona) test x-y plots after manufacture and prior to shipment.
2. Submit field test reports as specified in Section 16950 - Field Electrical Acceptance Tests.

G. Cable lengths:
1. Submit installed cable lengths using a conduit measuring tape for all medium voltage circuits.

H. Record documents:
   1. Submit record documents with any field modification.

## 1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Minimum of 10 years of experience in manufacturing medium voltage power cables.

B. Medium voltage cables shall be UL listed and labeled.

## 1.06 DELIVERY STORAGE AND HANDLING

A. Cables stored and or cut on site shall have the ends turned down, and sealed with cable manufacturer's standard cable end seals, or field installed heat-shrink cable end seals.

## 1.07 PROJECT OR SITE CONDITIONS

A. General site and project conditions:
   1. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Do not install cables until the Engineer reviews the Contractor prepared cable-pulling calculations:

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Furnish and install the complete medium voltage cable system.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. Okonite Co.
   2. Prysmian General Cable.
   3. Southwire Co.

## 2.04 MATERIALS

A. Conductors:
   1. Annealed uncoated copper in accordance with ASTM B3.
   2. Compact stranded in accordance with ASTM B496.

B. Insulation:
   1. Ethylene propylene rubber, (EPR).

C. Jacket:
   1. Polyvinyl chloride (PVC).

## 2.05 MANUFACTURED UNITS

A. General:
   1. Permanently mark each cable with the following at 24-inch intervals:
      a. American Wire Gauge (AWG) size or circular mill area.
      b. Voltage rating.
      c. Grade of insulation.
      d. UL symbol.
      e. Manufacturer’s name.

B. Medium voltage cable:
   1. Provide cables manufactured in the last 12 months.
   2. Voltage ratings as indicated on the Drawings or on the conduit schedule.
   3. Type MV-105:
      a. Rated for 105 degrees Celsius.
   4. Single conductor:
      a. Stranding:
         1) In accordance with ASTM B3 and B8 Class B.
   5. Conductor screen:
      a. Extruded semiconducting thermosetting compound.
      b. Applied directly over the conductor.
      c. In accordance with:
         1) AEIC CS8.
         2) UL 1072.
   6. Insulation level:
      a. 133 percent.
      b. Insulation screen:
         1) Extruded semiconducting thermosetting compound.
         2) Applied directly over the insulation.
         3) In accordance with:
            a) ICEA S-93-639 and ICEA S-97-682.
            b) Free-stripping.
         4) Provide color differentiation between semi-conducting layers and insulation.
   7. Concentric neutral:
      a. Concentric neutral shield consisting of solid bare copper wires helically applied and uniformly spaced over the insulation screen.
   8. Applications:
      a. Suitable for use in wet and dry locations in conduit and underground duct systems.
      b. Cables larger than AWG 1/0 suitable for CT use in cable tray.

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS (NOT USED)

## 2.08 ACCESSORIES (NOT USED)

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES (NOT USED)

## 2.11 SOURCE QUALITY CONTROL

A. Manufacturer cable in accordance with the latest standards of the ASTM and ICEA and test full cable length by these standards:
   1. AC withstand partial discharge (corona) test per AEIC CS8 and ICEA S-94-649.
      a. Results not to exceed 5 picocoulombs.

B. Provide cable reels with both ends of cables available for high-potential testing before installation.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION (NOT USED)

## 3.03 INSTALLATION

A. Install and terminate cable per manufacturer recommendations:
   1. Use proper stripping and terminating tools to ensure integrity of insulation.
   2. Ground shield at all terminations and splices.
   3. Maintain the manufacturer’s or NEC minimum bending radius, whichever is larger.
   4. Do not bend, kink, or nick cable jacket or insulation.
   5. Properly coat wires and cables with pulling compound recommended by cable manufacturer before pulling into conduits and prevent mechanical damage to conductors during installation:
      a. Other lubricants substituted must be accompanied by a statement from cable manufacturer as to its acceptable use with cables being installed.
   6. Do not exceed the pulling tension and sidewall pressures recommended by cable manufacturer. Install additional pull boxes as required to meet cable manufacturer's recommendations.
   7. Electrical identification: As specified in Section 16075 - Identification for Electrical Systems.
   8. Use only tools that are recommended by the termination or splice manufacturer.
   9. Use a dynamometer during cable pulling operations to monitor cable pulling tensions.

B. Cable pulling requirements:
   1. Cable pulling crew shall have “in hand” all cable pulling calculations and cable pulling limitations.
   2. Pull cable directly from reels into the ducts.
   3. Cable may not be laid on the ground or otherwise handled for cutting or sorting without protection from debris or physical damage.
   4. Follow cable manufacture installation instructions for proper handling.
   5. Do not pull cables through more than one intermediate manhole on one pull.
   6. Seal all cable ends against moisture or lubricant prior to pulling.
   7. Use non-metallic pull ropes to prevent cutting of duct materials.
   8. Pull cables from conductor, do not use cable pulling socks that attach to the insulation.
   9. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture.

C. Installation of cables in manholes and handholes:
   1. Install cables not utilizing the shortest route but routed along those walls providing the longest route and the maximum spare cable lengths.
   2. Run all cables closely parallel to the walls, not interfering with duct entrances.
   3. Support cables on brackets and cable insulators spaced at a maximum of four feet.
   4. In existing manholes and handholes where new ducts are to be terminated or where new cables are to be installed, modify the existing installation of cables, cable supports, and grounding as required for a neat and workmanlike installation with all cables properly arranged and supported.

D. Splices:
   1. Provide continuous circuits from origin to termination:
      a. Provide where necessary when cable pulling tension or sidewall pressure exceeds manufacturer recommendation for the cable.
   2. Make splices in manholes or pull boxes only:
      a. Leave sufficient slack to make proper connections.
      b. Do not pull splices into conduit.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL

A. After cable installation, test in accordance with ICEA/NEMA, including voltage tests, hi-potential tests, before energizing the circuits.
   1. Verify that no equipment is connected to the cables during tests.

END OF SECTION

## SECTION 16125

## FIBER OPTIC CABLE AND APPURTENANCES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Fiber optic cable.
   2. Fiber splices and terminations.
   3. Accessories.

### 1.02 REFERENCES

A. Abbreviations:
   1. N/Cm: Newtons per centimeter.
   2. OTDR: Optical Time Domain Reflectometer (Tier 2 test).
   3. OLTS: Optical Loss Test Set (Tier 1 test).

B. Standards:
   1. Bellcore Standards:
      a. GR-409 - Generic Requirements for Indoor Fiber.
   2. Electronic Industry Association (EIA):
      a. FOTP-25 - Impact testing of Fiber Optic Cables and Cable Assemblies.
      b. FOTP-33 - Fiber Optic Cable Tensile Loading and Bending Test.
      c. FOTP-41 - Compressive Loading Resistance of Fiber Optic Cables.
      d. FOTP-81 - Compound Flow (Drip) Test for Filled Fiber Optic Cable.
      e. FOTP-104 - Fiber Optic Cable Cyclic Flexing Test.
      f. FOTP-181 - Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components.
   3. Insulated Cable Engineer's Association (ICEA):
      a. S-83-596 - Optic Fiber Premises Distribution Cables.
      b. S-87-640 - Optic Fiber Outside Plant Communications Cable.
      c. S-104-696 - Indoor-Outdoor Optic Fiber Cable.
   4. TIA/EIA Standards:
      a. 598 - Optical Fiber Cable Color Coding.
      b. 11801 - Information technology - Generic cabling for customer premises.
   5. Underwriters Laboratories, Inc. (UL):
      a. 1666 - Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
      b. 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

### 1.03 TERMINOLOGY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

## 1.04 DELEGATED DESIGN (NOT USED)

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Complete manufacturer's brochures that identify materials and options.
   2. Completed datasheets, including catalog number and source for determining catalog number.
   3. Manufacturer's installation instructions.
   4. Include the following:
      a. Manufacturer's data on testing equipment used on this project.
      b. Manufacturer's specifications and datasheets for all fiber types.
      c. Manufacturer's specifications and datasheets for all connectors, bulkheads, splicing kits, breakout devices, and appurtenances used in connecting and terminating fiber spans.
   5. Catalog data on testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the NIST.
   6. Manufacturer's test procedures and quality assurance procedures:
      a. After review, Engineer may require that additional tests be performed before installation.

C. Shop Drawings:
   1. Interconnection cabling diagrams for the complete system including every fiber in each cable.
   2. Drawings indicating locations of all pull boxes including pull box identifiers and lengths.
   3. Submit optical power budget calculations for fiber segments. Include the following:
      a. Minimum transmit power of active devices.
      b. Minimum receive sensitivity.
      c. Available power, in dBm.
      d. Loss for each segment in dBm, including cable attenuation and connector losses. Use manufacturer's data for cable attenuation, at the wavelength to be used. Assume 0.5 dB per connector.
      e. Demonstrate that remaining power budget at each receiver is equal to or greater than 3.0 dBm.

D. Installation instructions:
   1. Submit a cable pulling and splicing work plan that includes the following:
      a. Pull tension calculations.
      b. Detailed description of pull operation methods for conduit runs.
      c. Tools and equipment to be used for cable installation and testing.
      d. Physical location of equipment setup and type.
      e. Exact locations of splice points.
      f. Safety and manual assist cable-pulling operations.
      g. Detailed schedule for pulling and testing cables.
      h. Name and qualifications of the supervisory personnel directly responsible for installation of the conduit system.
      i. Sample fiber optic cable test sheets.

j. Signed test sheet results.

E. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Manufacturer's representative qualifications.
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer's representatives field notes and data.

F. Operation and maintenance manuals:
   1. Compile completed test reports, instruction manuals, and manufacturer's information into the operating manuals and submitted in accordance with Section 01782 - Operation and Maintenance Manuals.

G. Test reports:
   1. Submit results of specified tests to the Engineer.
   2. Submit 3 copies of test reports showing results of tests specified in this Section or in Section 16950 - Field Electrical Acceptance Tests:
      a. Test forms shall include the following information at a minimum:
         1) Test type.
         2) Test location.
         3) Test date.
         4) Wavelength.
         5) Index of refraction.
         6) Cable identification.
         7) Fiber type.
         8) Fiber number.
         9) Fiber color.
         10) Result of the value of the tested parameter.
   3. Furnish hard copy and electronic copy for OTDR traces.
   4. Submit certification that the fiber optic cable has passed each testing stage:
      a. Submit separate documentation for each testing stage result.

H. Record documents:
   1. Furnish updated electrical drawings, network diagrams, and fiber cable block diagrams at the end of construction and submit as record drawings.

I. Calculations:
   1. Cable pulling calculations for conduit runs:
      a. Indicate on the Submittal any additional pull boxes that are required, including pull box identifiers and a written description of the location.

## 1.06 QUALITY ASSURANCE

A. Furnish cable and appurtenances manufactured within 1 year of installation.

B. Proof test optical fibers by the fiber manufacturer at a minimum load of 50 kpsi.

C. Provide 100 percent attenuation testing for optical fibers:
   1. Include with each cable reel the attenuation of each fiber.

D. Provide information on at least 5 successful fiber optic cable installations of comparable size and complexity in the past 3 years with name, address, and telephone number of facility owner, name of project with completion date, and type of conduit system and length of cable pulled.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Package cable for shipment on wooden reels:
   1. Seal both ends of cable to prevent ingress of moisture.
   2. Place fiber cable assemblies on reels such that both cable ends are available for testing.
   3. Weatherproof cable reel markings shall include the following:
      a. Manufacturer.
      b. Date of manufacture.
      c. Shipping date.
      d. Cable identification.
      e. Cable configuration/fiber count.
      f. Cable length.
      g. Gross weight.
      h. Cable test date.
      i. Handling instructions.
      j. Direction to unreel.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Submit a cable pulling and splicing work plan a minimum of 45 days before the planned initiation of cable pulling. Cable pulling and splicing work plan must be approved a minimum of 15 days before pulling cable.
   2. Testing sequence:
      a. Perform testing of each fiber in each cable as follows:
         1) At factory before shipment.
         2) At project site upon delivery.
         3) Submit copies of test results to the Engineer within 5 days after the delivery to the site.
         4) After installation, before breakout and terminations.
         5) After installation is complete.
      b. Submit test reports following each set of tests as specified in this Section.

B. Scheduling:
   1. Schedule Engineer, 5 days before installation, to witness cable installations.
   2. Notify the Engineer and Owner a minimum of 15 days before post-installation testing.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Furnish a complete fiber optic network as indicated on the Drawings.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Install fiber optic system components in accordance with the recommendations of the manufacturer.

## 2.03 MANUFACTURERS

A. Acceptable manufacturers are indicated with each component type as listed in the remainder of this Specification.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS

A. General fiber cable requirements:
   1. Suitable for the installed environment.
   2. Color-coded fibers according to EIA/TIA-598.
   3. Color-coded buffer tubes according to EIA/TIA-598.
   4. Furnish buffer tubes of a single layer nylon construction or of a material with similar mechanical performance.
   5. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
   6. Apply binders with sufficient tension to secure buffer tubes to the central member without crushing the buffer tubes:
      a. Provide binders that are:
         1) Non-hygroscopic.
         2) Non-wicking (or rendered so by the flooding compound).
         3) Dielectric with low shrinkage.
   7. Provide a minimum of 1 ripcord under the cable sheath.
   8. Provide high tensile strength Aramid yarns, Kevlar, and/or fiberglass helically stranded evenly around the cable core:
      a. No metallic elements whatsoever are allowed in non-armored cable.
   9. Jacket or sheath shall be free of holes, splits, and blisters.
   10. Mark jacket or sheath with:
      a. Manufacturer's name.
      b. “Optical Cable”.
      c. Year of manufacture.
      d. Sequential meter marks.
      e. Repeat markings every 1-meter.
      f. Actual length of the cable to be within 1 percent of the length marking.

g. Marking must be in a contrasting color to the cable jacket.
h. Height of the marking:
    1) Approximately 2.5 millimeters.
11. Shipping, storage, and operating temperature range of the cable shall be -40 degrees Celsius to +70 degrees Celsius.
12. General performance characteristics:
    a. Rated tensile load of the cables:
        1) Indoor/outdoor:
            a) Short term: 1,330 N.
            b) Long term: 400 N.
    b. Non-armored fiber optic cables: Compressive load withstand of 220 N/cm applied uniformly over the length of the cable.
    c. Armored fiber optic cables: Compressive load withstand of 440 N/cm applied uniformly over the length of the cable.
    d. Average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm for a cable subjected to this load:
        1) With no measurable increase in attenuation after load removal.
    e. Test in accordance with EIA FOTP-41 except that the load must be applied at the rate of 3 millimeters to 20 millimeters per minute and maintained for 10 minutes.
    f. Capable of withstanding 25 cycles of mechanical flexing at a rate of 30 within 1 cycles/minute.
    g. Average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm at the completion of the test.
    h. For armored cables, any visible cracks causing separation of the armor and propagating more than 5 millimeters constitutes failure.
    i. Outer cable jacket cracking or splitting observed under 10X times magnification, constitutes failure.

B. Indoor/outdoor cable:
1. Cable construction:
    a. General:
        1) Cable type: Indoor/Outdoor - Flame retardant, low smoke, zero halogen, UV resistant.
        2) Fiber count: As indicated on the Drawings.
        3) Fiber type: As indicated on the Drawings.
        4) Buffer tube: Loose tube.
        5) Armoring: None.
        6) Waterproofing: Water blocking layer.
        7) Strength member:
            a) Loose tube: Utilize a central, nonmetallic strength member with a coefficient of thermal expansion similar to the fibers as the central anti-buckling member.
        8) Approvals and listings: UL 1666 and UL 1685.
        9) Design and test criteria: In accordance with ICEA S-104-696.
    b. Testing:
        1) Fibers in the cable:
            a) Proof test of 100 kpsi.
            b) Each optical fiber: Bellcore GR-409 strip force testing.
            c) No gaps are allowed between the coating material and the buffer material visible under a 50-power microscope.

c. Outer jacket material:
   1) Linear low-density polyethylene.
   2) Meet requirements of the NEC for use in indoor/outdoor areas (excluding plenums) without being enclosed in conduit.
   3) Flame retardant OFNR riser rated conforming to UL 1666.
   4) Printed with necessary UL marks and manufacturer identification.
   5) Sequential printing of footage in 2-foot increments.
   6) With a ripcord incorporated under the cable jacket.

C. Multimode fibers:
   1. Fibers in the cable must be usable fibers and meet required specifications.
   2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.
   3. Multimode fiber characteristics:
      a. Category: OM4 compliant with ISO/IEC 11801.
      b. Jacket color: Aqua or black.

D. Indoor/outdoor:
   1. Loose tube:
      a. Corning Cable Systems, Freedm®.
      b. CommScope, LazrSPEED/TerraSPEED.
      c. Maximum cable diameter: 0.3 inches.

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS (NOT USED)

## 2.08 ACCESSORIES

A. Patch cords:
   1. General:
      a. Connector types to match supplied equipment and patch panel terminations.
      b. Maximum length of patch cords: 25 feet.
      c. Provide 2 spare patch cords (or 1 duplex patch cord) of each type used at each PLC or network cabinet.
      d. Factory assembled and optically tested.
      e. Provide mode-conditioning cords for multimode fibers operating at 1,310 nm.
   2. Manufacturers: One of the following or equal:
      a. CommScope.
      b. Corning Cable Systems.

B. Fiber connectors:
   1. As specified in Section 17733 - Control Systems: Network Materials and Equipment.

C. Fiber optic identification/warning tags:
   1. Black letters on orange or yellow background.
   2. UV resistant polyethylene or other suitable material:
      a. Manufacturers: The following or equal:
         1) Almetek.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Verify the condition of the conduit system before installation of the fiber optic cable or inner duct.

B. Pass a test mandrel through fiber optic conduits prior to pulling fiber or installing inner duct.
   1. Run the mandrel in both directions.

C. Examine materials and equipment before installation and verify they are free from physical damage and defects.

### 3.02 PREPARATION

A. Equipment support and anchoring to structures:
   1. Prepare anchor setting template(s) and use to position anchors during construction of supporting structures.
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

B. Before fiber splicing terminating or testing activities, verify sufficient workspace is available to perform the activity without interferences from other trades.

C. Pre-installation test:
   1. Upon arrival at the site:
      a. Inspect the cable and reel for damage.
      b. Test fibers with an optical time domain reflectometer (OTDR) for fiber integrity.
      c. Verify that the fiber lengths are consistent with the cable manufacture.
      d. Verify that traces yield no point discontinuities.
   2. Complete test sequence and obtain approval from the Engineer of submitted test results before cable installation.

### 3.03 INSTALLATION

A. Install fiber optic patch cords in open network trays or in dedicated conduits no longer than 25 feet in length.

B. Install fiber optic cable in continuous lengths without intermediate splices, except where approved by the Engineer.

C. Cable installation:
   1. Properly attach the fiber optic cable's strength elements to a 600-pound breakaway swivel containing tension or shear pins using Kellums pulling grips that are a minimum of 18 inches long.
   2. Certify that cable tensile limits do not exceed cable pull tension and bend limits using tension monitoring devices.
   3. Leave an extra loop of fiber optic cable in each pull box.
   4. Conform with the cable manufacturer's specifications, practices, and the following requirements:
      a. When power equipment is used to install fiber optic cables, use low speeds and do not exceed a rate of 30 meters per minute.
      b. Do not exceed the tensile and bending limitation for fiber optic cables under any circumstances.
      c. Use large diameter wheels, pulling sheaves, and cable guides to maintain the specified bending radius.
      d. Use commercial dynamometers or load cells to monitor pulling tension.
      e. A nonfreezing type of swivel inserted between the pulling line and cable pulling grip to prevent twisting under strain.
      f. Cable to be installed using a breakaway swivel.
   5. Apply to conduits a lubricant at each conduit ingress and egress location during the pull operation:
      a. Pour or pump lubricant into the end of the conduit at the feed location at a nominal application rate of 3 gallons per 1,000 feet of cable.
      b. If the conduit is open at intermediate locations, then apply the appropriate proportion of lubricant at each opening.
      c. Continuously lubricate the cable as it is being pulled by pouring or pumping the lubricant into the conduit at the feed location and at each intermediate location.
      d. Station workers at each intermediate location as required.
      e. Remove excess lubricant that has collected.
      f. Remove and clean the surrounding area after cable installation.
   6. Install using a hydraulic capstan or winch equipped with a recording running line dynamometer graph which measures and records pulling tensions:
      a. Use pulling equipment with slip-load capability to allow the winch to maintain a constant pulling force without taking up the winch line.
      b. Use pulling equipment equipped with a hydraulic bypass set so that a maximum tension of 600 pounds is not exceeded.
      c. Use only equipment designed to prevent a preset pulling tension from being exceeded.
      d. Fiber optic cable manufacturer to provide the pulling tension setpoint.
      e. If during the pulling operation excessive tension is detected, cease operations and notify the Engineer.
   7. Position the cable reel at the feed point in alignment with the raceway and in such a position that the cable can be passed from the top of the reel in a long, smooth bend into the raceway system:
      a. Use of a cable feeder is required unless the cable is hand-pulled.
   8. Supply bull wheels, blocks, split wheels, cable feeders, and necessary equipment required to provide a clean and safe operation:
      a. Cable shall not be allowed to travel over any wheel or block that has a radius less than the minimum radius allowed by the cable manufacturer.

9. Minimize the use of snatch blocks and rollers to guide the cable into the conduit at the feed point:
    a. Slack feed by hand the cable into the feed point and raceway without the use of rollers.
10. Tend the cable reel at all times and turn by hand to provide the required cable slack:
    a. Under no circumstances shall the cable tension be allowed to turn the cable reel.
11. Use a rim roller, with a wheel radius greater than the minimum cable bending radius placed at the manhole or vault opening to prevent the cable from dragging on the manhole rim or steps.
12. Perform a continuous thorough visual inspection for flaws, breaks, and abrasions in the cable sheath as the cable leaves the reel and maintain a slow pulling speed to permit this inspection.
13. Damage to the sheath or finish of the cable is cause for rejecting the cable:
    a. Replace any cable damaged in any way during installation.
14. If the cable becomes damaged during installation, stop operations and notify the Engineer immediately:
    a. Engineer to determine whether to replace the entire reel of cable or to install a termination panel to eliminate the damaged section.
15. Document pulls by a graph which is annotated with the following information:
    a. Reel number.
    b. Pull point ID.
    c. Date and time.
    d. Explanations for abnormalities in readings or interruptions.
    e. Sign-off by Contractor and Engineer.
16. Under no conditions shall the fiber optic cable be left exposed or unattended.

D. Provide inner duct in fiber optic conduits as indicated on the Drawings, cable schedule, and as specified in Section 16130 - Conduits:
    1. Provide a pull rope in each unused inner duct.

E. After the cables are installed and spliced:
    1. Rack the cables:
        a. Loosely secure in racked position with wire ties.
        b. Attach imprinted plastic-coated cloth identification/warning tags to each cable in at least 2 locations in each handhole/manhole.

F. Splices:
    1. Provide field splices in a splice tray located in a waterproof splice enclosure:
        a. Manufacturers: The following or equal:
            1) Tyco/Raychem, FOSC style splice enclosure.
    2. Loop the individual fibers a minimum of 1 full turn within the splice tray to avoid macro/micro bending.
    3. After completion of cable terminations, neatly dress cables.
    4. Protect splices with a thermal shrink sleeve.
    5. Provide fusion type fiber optic cable splicing meeting the following requirements:
        a. Joins multimode or single mode fibers.
        b. Establishes a permanent fusion splice.
        c. Waterproof.
        d. Re-enterable, rearrangeable, and reusable.

e. Splice loss less than 0.10 dB.
f. Protected by a splice enclosure.

6. Requirement for outdoor fiber splice enclosures:
   a. Seal.
   b. Bond.
   c. Anchor.
   d. Protect fiber optic cable splices.
   e. Stand-alone unit that does not require an outer enclosure.
   f. Provide for a maximum of 6 cable entries in a butt-end configuration.
   g. Used in aerial, underground, and direct buried applications.
7. Requirement for indoor fiber splice enclosures:
   a. Anchor.
   b. Protect fiber optic cable splices.
   c. Stand-alone unit that does not require an outer enclosure.
   d. Suitable for the minimum number of splices at that location plus additional capacity for reconfigurations.
8. Re-splice any splice that has a loss greater than 0.10 dB.
9. Leave a minimum of 20 feet of fiber optic cable at each end of splice.

G. Terminations:
1. Terminate fiber inside a patch panel:
   a. Direct landing to a switch, router hub, or PLC will not be allowed.
2. Terminate outdoor cables using a breakout kit that seals the cable and provides physical protection for the fiber strands.
3. Terminate indoor cables using breakout kits with field installed terminators.
4. Labeling:
   a. Permanently label cable terminations. Use labels produced by a wire printer using pressure sensitive polyester labels.
   b. Label patch panels as specified in Section 16075 - Identification for Electrical Systems.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
1. Before shipment and while on the shipping reel, test 100 percent of fibers for attenuation:
   a. Copies of the results shall be:
      1) Maintained on file.
      2) Attached to the cable reel in a waterproof pouch.
      3) Submitted before the delivery of the cable to the job site to Engineer for approval.
2. Conduct the flex test in accordance with EIA FOTP-104 test condition I and III with a maximum sheave diameter of 20 times the cable OD.
3. Verify that the cable withstands 25 impact cycles with:
   a. Average increase in attenuation for fibers less than 0.20 dB at 1,550 nm.
   b. No evidence of cracking or splitting.
   c. Conduct test in accordance with EIA FOTP-25.

4. Certify that the cable withstands a tensile load of 2,700 N (600 pounds):
    a. Without exhibiting an average increase in attenuation of greater than 0.10 dB.
    b. Test in accordance with EIA FOTP-33 using a maximum mandrel and sheave diameter of 560 millimeters.
    c. Apply the load for 1 hour in Test Condition II.
5. Certify that the cable withstands a simulated lightning strike:
    a. Peak value of the current pulse greater than 105kA.
    b. Use a test current with a damped oscillatory maximum time-to-peak value of 15 µs (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz.
    c. Time to half-value of the waveform envelope 40 to 70 µs.
    d. Conduct the test in accordance with the EIA FOTP-181.
    e. In addition to the analysis criterion set forth in EIA FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e., core tube) and strength members must be intact after removal of the cable specimens from the test box.
6. Furnish test reports and Manufacturer’s Certificate of Source Testing.

C. Installation Verification:
1. Furnish Manufacturer’s Certificate of Installation Verification.

D. Functional Testing:
1. Conduct post-installation tests of the fiber optic system as specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL

A. Utilize personnel certified by the manufacturer with specific knowledge of the cable manufacturer's recommended installation procedures.

B. General:
1. Test results shall meet or exceed manufacturer specifications:
    a. Test each fiber of each cable for breaks, abnormalities, and overall attenuation characteristics.
2. Pre-installation tests and post-installation tests to be witnessed and signed off by Engineer and Owner.
3. Perform OLTS test with equipment capable and calibrated to show anomalies of 0.1 dB as a minimum:
    a. Test multimode fibers at 850 nm and 1,300 nm.
    b. Test single mode fibers at 1,310 and 1,550 nm.
4. Perform OTDR tests on fiber cables less than 100 meters with the aid of a launch cable:
    a. Adjust OTDR pulse width settings to a maximum setting of 1/1,000th of the cable length or 10 nanoseconds.

## 3.06 ADJUSTING (NOT USED)

## 3.07 CLEANING

A. Clean fiber optic connectors after termination and before testing. After cleaning, cover unterminated connectors with a protective boot.

B. At the completion of construction, touch up the finish on fiber patch panels and enclosures.

## 3.08 PROTECTION

A. Protect the fiber system from physical damage and the encroachment of dust, before, during, and after installation.

## 3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16130

CONDUITS

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Metallic conduits.
   2. Nonmetallic conduits.
   3. Conduit bodies.
   4. Conduit fittings and accessories.
   5. Conduit installation.

## 1.02 REFERENCES

A. Abbreviations:
   1. EFLX: Explosion proof flexible conduit.
   2. GRC: Galvanized rigid steel conduit.
   3. NPT: National pipe thread.
   4. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
   5. PVC: Polyvinyl chloride rigid nonmetallic conduit.
   6. SLT: Sealtight-liquidtight flexible conduit.

B. Standards:
   1. American National Standards Institute (ANSI):
      a. C80.1 - Electrical Rigid Steel Conduit.
   2. National Electrical Manufacturers Association (NEMA).National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
   3. Underwriters Laboratories (UL), Inc.:
      a. 6 - Standard for Safety Electrical Rigid Metal Conduit - Steel.
      b. 1203 -Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, shapes C, E, LB, T, X, etc.
   2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.

## 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures and Section 16070 - Hangers and Supports.

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Furnish complete manufacturer's catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
   2. Furnish complete manufacturer's recommended special tools to be used for installation, if required.

C. Shop Drawings:
   1. Furnish conduit routing plans for conduits before the installation of any conduit.
   2. Detail the intended routing of each conduit, conduit material and include supporting methods.
   3. Number conduits in accordance with the Contract Documents.
      a. Provide conduit labels as specified in Section 16075 - Identification for Electrical Systems.

D. Delegated Design Submittals:
   1. As specified in Section 16070 - Hangers and Supports.

E. Certifications:
   1. Furnish PVC-coated conduit manufacturer's valid, unexpired certification for each installer.

## 1.06 QUALITY ASSURANCE

A. Conduits, conduit bodies, and fittings shall be UL listed and labeled.

B. Every installer of PVC-coated metallic conduit shall be certified by the manufacturer for installation of the conduit, and be able to present a valid, unexpired installer certification card prior to installation beginning.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Do not expose non-metallic conduit to direct sunlight.

B. Do not store conduit in direct contact with the ground.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Before performing any trenching locate existing underground utilities.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide conduits, conduit bodies, fittings, junction boxes, and necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

B. Provide location and protection of existing underground utilities, underground conduit trenching, conduit and backfill necessary for the complete installation of underground conduits.

## 2.03 MANUFACTURERS

A. Galvanized rigid steel conduit:
   1. One of the following or equal:
      a. Allied Tube and Conduit.
      b. Western Tube and Conduit.
      c. Wheatland Tube Co.

B. PVC-coated rigid steel conduit:
   1. One of the following or equal:
      a. Allied.
      b. Calbond.
      c. NEC, Inc. BlackGuard.
      d. Ocal, Inc.
      e. Robroy Ind.

C. Sealtight-liquidtight flexible conduit:
   1. One of the following or equal:
      a. AFC Cable Systems.
      b. Anaconda.
      c. Electri-Flex Co.
      d. Southwire.

D. Explosion proof flexible conduit:
   1. One of the following or equal:
      a. Appleton.
      b. Crouse-Hinds.
      c. Hubbell Killark.

E. Rigid nonmetallic PVC conduit:
   1. One of the following or equal:
      a. Cantex.
      b. Carlon.
      c. Triangle Conduit and Cable.

F. Inner duct:
   1. One of the following or equal:
      a. Carlon.
      b. Endot Ind.
      c. MaxCell.

G. Conduit bodies:
   1. One of the following or equal:
      a. Appleton.
      b. Calbond.
      c. Carlon.
      d. Crouse-Hinds.
      e. O-Z/Gedney.
      f. Ocal, Inc.
      g. Robroy Ind.

H. Joint compound:
   1. As recommended by the conduit manufacturer.

I. Galvanized rigid steel conduit expansion fittings:
   1. One of the following or equal:
      a. Appleton.
      b. Crouse-Hinds.
      c. O-Z/Gedney.

J. PVC-coated rigid steel conduit expansion fittings:
   1. One of the following or equal:
      a. NEC, Inc. BlackGuard.
      b. Ocal, Inc.
      c. Robroy Ind.

K. Conduit seals:
   1. One of the following or equal:
      a. Appleton.
      b. Crouse-Hinds.
      c. O-Z/Gedney.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS

A. GRC:
  1. NPT standard conduit threads with a 3/4-inch taper per foot:
     a. Running conduit threads are not acceptable.
  2. Hot-dip galvanized inside and out:
     a. Ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface.
     b. Electro-galvanizing is not acceptable.
  3. Manufactured in accordance with:
     a. UL 6.
     b. ANSI C80.1.

B. PCS:
  1. Steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, in accordance with to the requirements for Type GRC.
  2. Coated conduit NEMA Standard RN-1:
     a. Galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
  3. Factory-bonded PVC jacket:
     a. Exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
     b. Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.
     c. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
     d. PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
        1) Confirm bond with certified test results.
  4. Urethane coating shall be uniformly and consistently applied to the interior of conduits and fittings:
     a. Nominal thickness of 0.002 inch.
     b. Conduits having areas with thin or no coating are not acceptable.
     c. Threads shall be coated with urethane.
  5. PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
  6. PCS conduit bodies and fittings:
     a. Malleable iron.
     b. Conduit body, before PVC coating, shall be new, unused material and shall be in accordance with appropriate UL standards.
     c. PVC coating on the outside of conduit bodies shall be 0.040-inch thick and have a series of ribs to protect the coating from tool damage during installation.
     d. 0.002-inch interior urethane coating.
     e. Utilize PVC coating as an integral part of the gasket design.
     f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.

g. PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
    1) Inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
    2) Sleeve shall provide a vapor- and moisture resistant seal at every connection.
    3) Fittings shall be Form 8 and supplied with plastic encapsulated stainless steel cover screws. Fittings shall be UL Type 4X. Fittings shall be from the same manufacturer as the conduit in order to maintain system continuity and warranty.

C. SLT:
1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
    a. General purpose:
        1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
    b. Oil-resistant:
        1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
2. Sunlight-resistant, weatherproof, and watertight.
3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
5. Overall PVC jacket.
6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.

D. EFLX:
1. Suitable for the hazardous Class and Group where installed:
    a. As specified in Section 16050 - Common Work Results for Electrical.
2. Metallic braid shall provide continuous electrical path.
3. Stainless steel construction.
4. Provide fittings and unions as required for the installation.

E. PVC:
1. Extruded from virgin PVC compound:
    a. Schedule 40 unless otherwise specified.
    b. Schedule 80 extra-heavy wall where specified.
2. Rated for 90 degrees Celsius conductors or cable.
3. Rated for use in direct sunlight.

F. Inner duct:
1. HDPE and fabric inner duct are considered interchangeable.
2. HDPE inner duct:
    a. High-density polyethylene.
    b. Corrugated.
    c. Resin properties:
        1) Density, g/cm$^3$: 0.941 to 0.955.
        2) Melt index g/10-minute Condition E: 0.05 to 0.5.
        3) Flexural modulus, MPa (pounds per square inch): 80,000 minimum.
        4) Tensile strength at yield (pounds per square inch): 3,000 minimum.

5) Environmental stress crack resistance condition B, $F_{10}$: 96 hours minimum.
6) Brittleness temperature: -75 degrees Celsius.

d. Size: 1.25 inch.
e. Colors: Orange.

3. Fabric inner duct:
   a. White polyester and nylon resin polymer textile.
   b. Standard outdoor textile inner duct:
      1) 3-inch multi-cell inner duct containing pull tape in each cell.
   c. Color-coded.
   d. Pull tape:
      1) 1,250 pound.
      2) Synthetic fiber polyester, flat woven.
      3) Printed sequential footage marks.

G. Conduit bodies:
1. Material consistent with conduit type:
   a. Malleable iron bodies and covers when used with Type GRC.
   b. PVC-coated malleable iron bodies and covers when used with Type PCS.
   c. Malleable iron bodies with pressed steel.
2. Conduit bodies to be in accordance with to Form 8, Mark 9, or Mogul design:
   a. Mogul design in accordance with NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with conductors #4 AWG and larger, or where required for wire-bending space.
3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

## 2.08 ACCESSORIES

A. Connectors and fittings:
1. Manufactured with compatible materials to the corresponding conduit.

B. Insulated throat metallic bushings:
1. Construction:
   a. Malleable iron or zinc-plated steel when used with steel conduit.
   b. Positive metallic conduit end stop.
   c. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
   d. Use fully insulated bushings on nonmetallic conduit system made of high-impact 150 degrees Celsius rated non-combustible thermosetting phenolic.

C. Insulated grounding bushings:
1. Construction:
   a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
   b. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
   c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.

D. Electrical unions (Erickson Couplings):
   1. Construction:
      a. Malleable iron for use with steel conduit.
      b. PVC-coated malleable iron for use with PCS conduit.
      c. Concrete tight, 3-piece construction.
      d. Rated for Class I Division 1 Group D in hazardous areas.

E. SLT fittings:
   1. Construction:
      a. Malleable iron.
      b. Furnished with locknut and sealing ring.
      c. Liquidtight, raintight, oiltight.
      d. Insulated throat.
      e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
      f. Designed to prevent sleeving:
         1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
      g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device, if inserted into raceway and directly in contact with conductors, shall have rolled-over edges for sizes under 5 inches.
      h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.
   2. Corrosion-resistant and outdoor SLT fittings:
      a. Construction:
         1) PVC-coated liquidtight fittings with a bonded 0.040-inch-thick PVC coating on the metal connector to form a seal around the SLT conduit.
         2) Insulated throat and an integral sealing ring.

F. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
   1. Construction:
      a. Insulated throat.
      b. PVC-coated when used in corrosive areas.
      c. Bonding locknut.
      d. Recessed neoprene O-ring to ensure watertight and dusttight connector.
      e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
      f. 1-1/2-inch through 6-inch malleable iron zinc plated.
   2. Usage:
      a. Conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.

G. Sealing fittings:
   1. Construction:
      a. 40-percent wire fill capacity.
      b. PVC-coated when used in corrosive areas.
      c. PVC Coated Hazardous (Classified) Location fittings must be UL 1203 listed after the coating is applied and have a red metal tag attached to the fitting to signify compliance.
      d. Malleable ductile iron with steel conduit.
      e. Type EYDX where drains are required.
      f. Type EYSX where drains are not required.
      g. UL 1203 listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.
   2. Sealing compound:
      a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
      b. Approved for the conditions and use.
         1) Not affected by surrounding atmosphere or liquids.
      c. Melting point shall be 200 degrees Fahrenheit minimum.

H. Expansion/deflection couplings:
   1. Use to compensate for movement in any direction between 2 conduit ends where they connect.
   2. Shall allow movement of 3/4 inch from the normal in all directions.
   3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
   4. Constructed to maintain electrical continuity of the conduit system.
   5. Materials:
      a. End couplings: Bronze or galvanized ductile iron.
      b. Sleeve: Neoprene.
      c. Bands: Stainless steel.
      d. Bonding jumper: Tinned copper braid.

I. Expansion couplings:
   1. Shall allow for expansion and contraction of conduit:
      a. Permitting 8-inch movement, 4 inches in either direction.
   2. Constructed to maintain electrical continuity of the conduit system.
   3. Materials:
      a. Head: Malleable or ductile iron.
      b. Sleeve: Steel.
      c. Insulating bushing: Phenolic.
      d. Finish: Hot-dip galvanized.
      e. PVC-coated steel when used with Type PCS.

J. Inner duct couplings and fittings:
   1. HDPE inner duct:
      a. Couplings:
         1) Self-threading.
         2) Nonmetallic.

b. Fittings:
   1) Multi-access fitting:
      a) 3-hole.
      b) Sized for conduit containing inner duct.
   2) Duct plugs:
      a) Sized for inner duct diameter.
      b) Install in both ends of unused ducts.
   3) Split plugs:
      a) Sized for inner duct and cable diameters.
      b) Install at both ends of utilized ducts.

2. Fabric inner duct:
   a. Termination bags:
      1) Inflation-type bags for sealing and securing around 1 or more textile inner ducts and cables within 2-inch outside diameter or larger conduit.

K. Conduit markers:
   1. As specified in Section 16075 - Identification for Electrical Systems.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Before installing any conduit or locating any device box:
   1. Examine the complete set of Drawings and Specifications, and applicable Shop Drawings.

B. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. General:
   1. Conduit routing:
      a. Electrical drawings are diagrammatic in nature:
         1) Install conduit runs as specified with schematic representation indicated on the Drawings and as specified.
         2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
            a) Make changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions.
            b) Make changes in conduit routing due to the relocation of equipment.
            c) Install conduits and equipment in such a manner as to avoid obstructions and to preserve headroom and keep openings and passageways clear.

3) Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.
4) Electrical drawings do not indicate all required junction boxes and pull boxes:
a) Provide junction boxes and pull boxes to facilitate wire pulling as required:
(1) To meet cable manufacturer's pulling tension requirements.
(2) To limit total conduit bends between pull locations.
b) Install junction boxes and pull boxes at locations acceptable to the Engineer.

b. Contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer:
1) Engineer is the sole source in determining whether the change is constituted as a deviation.
2) Perform any changes resulting in additional conduits, or extra work from such deviations.
3) Incorporate any deviations on the Record Documents.

2. Use only tools recommended by the conduit manufacturer for assembling the conduit system.
3. Provide adequate clearances from high-temperature surfaces for conduit runs. Provide minimum clearances as follows:
a. Clearance of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.
b. Clearance of 12 inches from surfaces greater than 149 degrees Fahrenheit.
c. Keep conduits at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings, and 12 inches from fuel lines and gas lines.
d. Where it is necessary to route conduits close to high-temperature surfaces, provide a high-reflectance thermal barrier between the conduit and the surface.
4. Support conduit runs on water-bearing walls a minimum of 7/8-inch away from wall on an accepted preformed channel:
a. Do not run conduits within water-bearing walls unless otherwise indicated on the Drawings.
5. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.
6. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
b. Make changes in direction with long radius bends or with conduit bodies.
7. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.
8. Route exposed conduits to preserve headroom, access space and workspace, and to prevent tripping hazards and clearance problems:
a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.

b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.

9. Conduits may be run in concrete members or slabs with permission of the Engineer or as indicated on the Drawings:
   a. Refer to the typical details for conduit spacing and size requirements.
10. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.
11. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
12. Install conduits through wall and floor seals where indicated on the Drawings.
13. For existing and new 2-inch and larger conduit runs, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit:
   a. Remove and replace conduits through which mandrel will not pass.
14. Provide sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.
15. Install complete conduit systems before conductors are installed.
16. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.
17. Underground conduits:
   a. Install underground conduits, including conduit runs below slabs-on-grade in concrete-reinforced duct bank construction:
      1) As specified in Section 16133 - Duct Banks.
   b. Make underground conduit size transitions at handholes and manholes.
   c. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and handholes.
   d. Seal around conduit penetrations of below grade walls with a mechanical seal.
18. Underground conduit trenching:
   a. Perform trenching as specified in Section 02318 - Trenching.
   b. Trench must be uniformly graded with the bottom, rock free and covered with select material.
   c. Damage occurring to existing ducts, conduits, cables, and other utilities during underground conduit installation shall be remediated to the satisfaction of the Owner.
   d. Whenever possible, use the walls of the trench as forms for concrete encasement:
      1) Forms are required where the soil is not self-supporting.

B. Equipment grounding conductors:
1. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:
   a. Multi-conductor power and control cables shall include an integral green insulated grounding conductor.
   b. Provide a separate grounding conductor in each individual raceway for parallel feeders.

2. Conductors shall be the same type and insulation as the circuit conductors:
    a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
3. Minimum size in accordance with the NEC.

C. Lighting and receptacle conduits:
1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings.
2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.
3. Minimum conduit size:
    a. 3/4-inch for exposed conduits.
    b. 1-inch for underground or in-slab conduits.
4. Provide conduit materials for the installed location as specified in Section 16050 - Common Work Results for Electrical.

D. Hazardous areas:
1. As specified in Section 16050 - Common Work Results for Electrical for hazardous areas and specific Class and Division.

E. Conduit usage:
1. Exposed conduits:
    a. Rigid conduit:
        1) Install the rigid conduit type for each location as specified in Section 16050 - Common Work Results for Electrical.
        2) Minimum size: 3/4-inch.
    b. Flexible conduit:
        1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
            a) Use Type SLT with rigid metallic conduit.
            b) Use Type EFLX in Class I Division 1 locations.
        2) Minimum size: 3/4-inch:
            a) 1/2 when required for connection to instruments.
        3) Maximum length:
            a) Fixed equipment:

| Conduit Trade Size | Flexible Conduit Length (inch) |
|---|---|
| 3/4 | 18 |
| 1 | 18 |
| 1-1/4 | 18 |
| 1-1/2 | 18 |
| 2 | 36 |
| 2-1/2 | 36 |
| 3 | 36 |
| 3-1/2 | 38 |
| 4 | 40 |

b) Removable instruments or hinged equipment:
(1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.

2. Concrete-encased and embedded conduits:
a. Straight runs and bends less than 45 degrees:
1) Type PVC Schedule 40.
b. Bends with total deflection greater than 45 degrees:
1) PCS.
c. Entering and exiting duct bank, underground or embedded conduit runs a minimum 12 inches above and below grade, finished floor, or entering equipment:
1) PCS.
d. Minimum size:
1) Two-inch in duct banks.
2) One-inch for in-slab conduits.
3) Provide conduit fittings to enlarge the conduit from the exposed size in the conduit schedule as required.
3. Direct-buried and sand-bedded duct bank conduits:
a. Type PCS.
b. Minimum size: 1-inch.
4. Concrete capped, pea gravel-bedded duct bank conduits:
a. Type PVC40.
b. Minimum size: 1-inch.
5. PVC-coated rigid metallic conduit:
a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
b. Repair damage to PVC coatings with manufacturer supplied touchup compound or PVC Coating Repair Kit for PVC Coated Raceway Systems.
6. GRC:
a. Conduit shall be cut square and reamed before threading.
7. Inner duct (applicable for fiber optic cable only):
a. Install inner duct in conduits as indicated on the Drawings.
b. Each inner duct conduit shall be a separate color.

F. Conduit joints and bends:
1. General:
a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquidtight.
b. Keep bends and offsets in conduit runs to an absolute minimum.
c. Bends shall be symmetrical.
d. For all types of high-voltage conductors, provide bends as required for lead-covered conductors of equivalent outside diameter.
e. The following conduit systems shall use large-radius sweep elbows:
1) Underground conduits.
2) Conduits containing medium-voltage cables.
3) Conduits containing shielded cables.
4) Conduits containing fiber optic cables.
f. Provide large-radius factory-made bends for 1-1/4-inch trade size or larger.

g. Make field bends with a radius of not less than the requirements found in the NEC:
    1) Minimum bending radius of the cable must be less than the radius of the conduit bend.
    2) Make field bends with power bending equipment or manual benders specifically intended for the purpose:
        a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
        b) For the serving utilities, make bends to meet their requirements.

h. Replace deformed, flattened, or kinked conduit.

2. Threaded conduit:
    a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that joints become secure and wrench-tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
    b. Thoroughly ream conduit after threads have been cut to remove burrs.
    c. Use bushings or conduit fittings at conduit terminations.
    d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing "Galvabar™," or CRC "Zinc It."
    e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:
        1) Apply to the male threads and tighten joints securely.
        2) Clean excess sealant from exposed threads after assembly.
    f. Securely tighten threaded connections.
    g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that exposed surfaces have a galvanized protective coating.

3. PVC:
    a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray-type cement is not allowed.
    b. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to ensure full inside diameter at bends:
        1) Utilize a heater specifically for PVC conduit as recommended by the conduit manufacturer.

G. Conduit sealing and drainage:

1. Other than required for hazardous and classified areas:
    a. Provide sealing and drainage in vertical drops of long (in excess of 20 feet), exterior, above-grade conduit runs at the points at which the conduit enters buildings, switchgear, control panels, lighting panelboards, and other similar enclosures.
    b. Provide seal fittings with drains in vertical drops directly above grade for exterior and above-grade conduit runs that are extended below grade.
    c. Provide conduit seals with drains in areas of high humidity and rapidly changing temperatures:
        1) Where portions of an interior raceway pass through walls, ceilings, or floors that separate adjacent areas having widely different temperatures.

d. Provide conduit seals similar to O-Z/Gedney (Type CSM) on conduits between corrosive and non-corrosive areas.
e. Seal 1 end only of underground conduits at highest point with O-Z/Gedney sealing (non-hazardous) filling, or equal.

2. Install seals with drains at any location along conduit runs where moisture may condense or accumulate. This requirement includes, but is not limited to, the following locations: Control panels, junction boxes, pullboxes, or low points of the conduit.

H. Hangers and supports:

1. General:
   a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
      1) As specified in Section 16070 - Hangers and Supports.
      2) Provide support materials consistent with the type of conduit being installed as specified in Section 16050 - Common Work Results for Electrical.
   b. Support conduit at the intervals required by the NEC.
   c. Perforated strap and plumbers' tape are not acceptable for conduit supports.
2. Conduit on concrete or masonry:
   a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
   b. Use preset inserts in concrete when possible.
   c. Use pipe spacers (clamp backs) in wet locations.
3. Suspended conduit:
   a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
   b. For grouped conduits, construct racks with threaded rods and tiered angle iron or preformed channel cross members. Clamp each conduit individually to a cross member. Where rods are more than 2-feet long, provide rigid sway bracing.
4. Supports at structural steel members:
   a. Use beam clamps.
   b. Drilling or welding may be used only as specified or with approval of the Engineer.
5. PVC-coated rigid metal systems:
   a. Provide right-angle beam clamps and "U" bolts specially formed and sized to snugly fit the outside diameter of the coated conduit. Provide "U" bolts with PVC-encapsulated nuts that cover the exposed portions of the threads.
   b. Securely fasten exposed conduits with Type 316 stainless steel clamps or straps.

I. Expansion or expansion/deflection fittings:
   1. General:
      a. Align expansion coupling with the conduit run to prevent binding.
      b. Follow manufacturer's instructions to set the piston opening.
      c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction.
      d. Furnish fittings of the same material as the conduit system.
   2. For metallic conduit, provide expansion or expansion/deflection couplings, as appropriate, where:
      a. Install expansion fittings a minimum of every 200 feet in straight conduit runs.

J. Empty conduits:
   1. Provide a pull tape in each empty conduit more than 10 feet in length.
   2. Seal ends of conduits with approved, manufactured conduit seals, caps, or plugs immediately after installation:
      a. Keep ends sealed until immediately before pulling conductors.

K. Miscellaneous:
   1. Seal roof penetrations for raceways and other items that penetrate the roof in accordance with roofing manufacturer's instructions and as indicated on the Drawings.
   2. Provide electrical unions at all points of union between ends of rigid conduit systems that cannot otherwise be coupled:
      a. Running threads and threadless couplings are not allowed.
   3. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.
   4. Provide conduit housekeeping curb around embedded or below-grade conduits exiting or entering the slab, in accordance with the Typical Details.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

**SECTION 16133**

**DUCT BANKS**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Electrical underground duct banks.
   2. Duct bank installation requirements.

### 1.02 REFERENCES

A. Underwriters Laboratories, Inc. (UL).

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. PVC conduit spacers.
   2. Detectable underground marking tape.
   3. Pull line.

C. Shop Drawings:
   1. Submit site plan drawings of duct banks including underground profiles indicating underground utilities.
   2. Submit cross section of each duct bank with dimensions.
   3. For duct bank routings crossing under building footers or foundations alternative to designed routings indicated on the Drawings:
      a. Submit Shop Drawings detailing the new building footer crossing locations and plan drawings labeling equipment to be installed on top of the new routing for approval by the Project structural Engineer.

### 1.05 QUALITY ASSURANCE (NOT USED)

### 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

### 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Before performing any trenching locate existing underground utilities.

B. Scheduling:
   1. Schedule a coordination meeting to adjust duct bank configurations and routing for each duct bank section after trenching and exposure of any underground utilities withing the vicinity of the duct bank route. Meeting shall determine the final configuration of the duct bank before installation.

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Duct bank sections indicated on the Drawings are an initial arrangement and may need to be modified due to existing site conditions, existing underground utilities, and infrastructure.
   1. Reorganize duct bank section with approval of the Engineer.
   2. Make changes required to accommodate duct bank configuration and routing changes due to field conditions.
      a. Where changes in a duct bank configuration extend to a manhole or handhole, coordinate manhole/handhole block outs and size with the new configuration.

B. Provide location and protection of existing underground utilities, duct bank, trenching, forming, rebar, spacers, conduit, concrete, backfill, and compaction necessary for the complete installation of the duct banks.

C. Provide reinforced concrete duct banks for conduits installed below grade, on the site, below structures, or in contact with the earth, unless otherwise indicated on the Drawings.

## 2.03 MANUFACTURERS

A. Conduit spacers:
   1. One of the following or equal:
      a. Cantex.
      b. Osburn Associates, Inc.

B. Detectable underground marking tape:
   1. One of the following or equal:
      a. Blackburn Manufacturing Co.
      b. Panduit.

C. Pull line:
   1. One of the following or equal:
      a. Arnco.
      b. Greenlee.
      c. Osburn Associates, Inc.

D. Duct seal:
   1. The following or equal:
      a. O-Z/Gedney type DUX.

## 2.04 MATERIALS

A. Provide conduit as specified in Section 16130 - Conduits.

B. Provide reinforcing steel as specified in Section 03200 - Concrete Reinforcing:
   1. Provide minimum Number 4 reinforcing steel.

C. Concrete:
   1. Mix requirements as specified in Section 03300 - Cast-in-Place Concrete.
   2. Provide a red-oxide conduit encasement coloring agent as specified in Section 03300 - Cast-in-Place Concrete.

## 2.05 MANUFACTURED UNITS

A. Conduit spacers:
   1. Recommended by the conduit manufacturer or specified above.
   2. Saddle type.
   3. Non-metallic, non-corrosive, non-conductive.
   4. Interlocking type:
      a. Vertical interlocking.
      b. Horizontal interlocking.
   5. Suitable for concrete encasement.
   6. Molded-in rebar holder.
   7. Accommodates 2-inch through 6-inch conduit sizes.
   8. Relieves the conduit from both horizontal and vertical stresses.

B. Pull line:
   1. Minimum 1/4-inch wide, flat design.
   2. Polyester.
   3. Minimum pulling strength 1,200 pounds.
   4. Sequential footage markings.

C. Detectable marking tape:
   1. Locatable by a cable or metal detector from above the undisturbed grade.
   2. Aluminum core laminated between polyethylene film.
   3. 6-inch-wide red tape imprinted with black lettering stating “CAUTION - BURIED ELECTRIC LINE BELOW”, or equivalent.

D. Duct seal:
   1. Non-hardening sealing compound.
   2. Flexible, can be applied by hand.

3. UL Listed for use with installed conductors.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION (NOT USED)

## 3.03 INSTALLATION

A. Duct banks:
   1. Encased in concrete at least 24 inches below finish grade, unless otherwise indicated on the Drawings.
   2. Damage minimization:
      a. Conduit should not be left exposed in an open trench longer than is necessary.
      b. Protect underground duct banks against damage during pouring of concrete or backfilling.
   3. Plastic conduit fittings to be joined should be exposed to the same temperature conditions for a reasonable length of time before assembly.
   4. Provide No. 4/0 American Wire Gauge bare copper ground wire the entire length of duct bank and bond to the grounding system at each end of the duct bank:
      a. Where duct bank terminates at structures with a grounding electrode, bond duct bank ground wire to the grounding electrode.
      b. Where duct bank terminates at electrical equipment, bond duct bank ground wire to the equipment ground bus.
      c. Where duct bank terminates at structure without either a grounding electrode or electrical equipment, provide ground rod adjacent to structure and bond duct bank ground wire to ground rod.
   5. Install underground ducts to be self-draining:
      a. Slope duct banks away from buildings to manholes, handholes, or pullboxes.
      b. Slope duct banks uniformly from manholes, handholes, or pullboxes to manholes, handholes, or pullboxes or both ways from high points between manholes, handholes, or pullboxes.
      c. Slope a minimum of 1/4 inch per 10 feet.
   6. Where new duct banks join to existing manholes, handholes, or pullboxes, make the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions, as indicated on the Drawings.
   7. Install pull line in spare conduits:
      a. Provide adequate pull line at both ends of conduits to facilitate conductor pulling.
      b. Cap above ground spare conduit risers at each end with screw-on conduit caps.

B. Trenching:
   1. Perform as specified in Section 02318 - Trenching.
   2. Trench must be uniformly graded with the bottom rock free and covered with select material.

3. Whenever possible, use the walls of the trench as forms for concrete encasement:
    a. Forms are required where the soil is not self-supporting.
4. Damage occurring to existing ducts, conduits, cables, and other utilities during duct bank installation shall be remediated to the satisfaction of the Owner.

C. Duct spacing:
1. Separate conduits with manufactured plastic spacers using a minimum space between the outside surfaces of adjacent conduits of 2 inches, 3 inches for medium voltage conduits 4-inch and smaller, unless otherwise indicated on the Drawings:
    a. Separate medium voltage ducts a minimum of 7.5 inches on center.
2. Install spacers to maintain uniform spacing of duct assembly a minimum of 4 inches above the bottom of the trench during concrete pour. Install spacers on 8-foot maximum intervals:
    a. Due to some distortion of conduit from heat, and other means, it may be necessary to install extra spacers within the duct bank:
        1) Install the intermediate set of spacers within normal required spacing to maintain the proper horizontal clearance:
            a) Clearance is required to allow the proper amount of concrete to infiltrate vertically among the duct to ensure proper protection.
3. Spacers shall not be located at the center of a bend:
    a. Locate spacer in the tangent, free of the coupling on fabricated bends.
    b. Locate spacers midway between the tangent and the center bend on trench formed sweeps.

D. Terminating:
1. Use bell ends in duct at entrances into cable vaults.
2. Make conduit entrances into cable vaults tangential to walls of cable vault.
3. Form trapezoidal transitions between duct bank and cable vaults as needed in order to ensure adequate cable bending radius for the duct bank-to-vault transition.
4. Install duct seal in all conduits, including spare conduits, at entrance to manholes/handholes, and building/equipment stub-ups. Form by hand to conduit and around cables to develop moisture barrier.
5. New manhole or handhole applications, provide a single opening or “window” per duct bank, sized to accommodate the duct bank envelope.

E. Concrete:
1. Install concrete as specified in Section 03300 - Cast-in-Place Concrete.
2. Provide tie wires as specified in Section 03200 - Concrete Reinforcing to prevent displacement of the conduits during pouring of concrete:
    a. Tie wire shall not act as a substitute for spacers.
3. Install minimum 3-inch cover around conduit and rebar.
4. Consolidation of encasement concrete around duct banks shall be by hand puddling. Mechanical vibrators are acceptable for use outside of the rebar cage.
5. Conduit is subject to temperature rise. As concrete cures, allow the free end to expand by pouring the concrete from the center of the run or from one tie in point.

F. Marking tape:
  1. Install a detectable marking tape 12 inches above the duct bank the entire length of the duct bank.

G. For conduit installations beneath building slabs:
  1. Duct banks shall be continued under building slabs to the final destination of the conduits.
     a. Construct separate duct banks as required.
     b. Concrete for encasement under building slabs need not be colored red.
     c. For duct banks crossing under building footers or foundations, install the top of the duct bank a minimum of 12inches below the footer.
     d. Where duct banks enter through building walls, foundation walls, stem walls, etc., make connections as indicated on the Drawings.
     e. Where duct banks terminate with conduit risers entering building walls, install an expansion/deflection fitting or a flat-wise elbow (elbow parallel to building wall) in order to accommodate differential movement between the conduits and structure.

H. Restore surfaces to their original condition as specified in Section 02952 - Pavement Restoration and Rehabilitation unless otherwise specified.

I. Marking piers:
  1. Provide permanent concrete cylinder marking piers, on grade, centered on duct bank and located at every bend in duct bank or wherever duct bank enters a building, vault, or other structure:
     a. Provide a cylinder, 6 inches in diameter:
        1) Top of cylinder 1/2 inch below the top of finished grade.
     b. Provide a 3-inch high “E” embossed in top of cylinder:
        1) Minimum of 2 inches deep.
     c. Provide 2-inch arrows embossed in top of cylinder showing the direction of the duct bank:
        1) Minimum of 2 inches deep.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

## 3.05 FIELD QUALITY CONTROL (NOT USED)

## 3.06 ADJUSTING (NOT USED)

## 3.07 CLEANING

A. Clean conduits of dirt and debris by use of an appropriately sized steel mandrel no less than 1/2 inch smaller than the inside diameter of the conduit.

## 3.08 PROTECTION

A. Provide shoring and pumping to protect the excavation and safety of workers.

B. Protect excavations with barricades as required by applicable safety regulations.

END OF SECTION

## SECTION 16134

## BOXES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Device boxes.
   2. Raceway system boxes.

### 1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Castings.

C. Joint Industry Conference (JIC).

D. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

E. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

F. Underwriters Laboratories, Inc. (UL).

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.
   2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

### 1.04 DELEGATED DESIGN (NOT USED)

### 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Materials.
   3. Dimensions:
      a. Height.

b. Width.
c. Depth.
d. Weight.
e. NEMA rating.
4. Conduit entry locations.
5. Catalog cutsheets.
6. Installation instructions.

C. Shop Drawings:
1. Include identification and sizes of pullboxes.

## 1.06 QUALITY ASSURANCE

A. Regulatory requirements:
1. Outlet boxes shall comply with applicable standards of:
a. JIC.
b. NEC.
c. NEMA.
d. UL.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide outlet boxes for wiring devices, security systems, junction, and pullboxes for use in the raceway systems, etc.

B. Provide boxes as indicated on the Drawings or as needed to complete the raceway installation.

C. Size pullboxes in accordance with NEC requirements and to provide sufficient room for any future conduits, components, and cables as indicated on the Drawings.

D. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 16050 - Common Work Results for Electrical.

E. For boxes not indicated:
   1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in Section 16050 - Common Work Results for Electrical.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. Pressed steel boxes and concrete boxes:
      a. ABB
      b. Appleton.
      c. Crouse - Hinds.
   2. Plastic coated boxes:
      a. OCAL.
      b. Rob Roy.
   3. Cast device boxes:
      a. Appleton.
      b. Crouse - Hinds.
      c. O-Z/Gedney.
   4. Explosionproof enclosures:
      a. Adalet.
      b. Crouse-Hinds.
      c. O-Z/Gedney.
   5. Formed steel enclosures:
      a. Hoffman.
      b. Rittal
      c. Stahlin.
   6. Stainless steel enclosures:
      a. Hoffman.
      b. Rittal.
      c. Stahlin.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS

A. Pressed steel boxes:
   1. 1-piece galvanized pressed steel.
   2. Knockout type boxes.
   3. Minimum size 4-inch square by 2-1/8-inch deep.

B. Cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Tapered threaded hubs with integral bushing.
   2. Malleable iron boxes:
      a. In accordance with ASTM A47 Grade 32510.

C. Plastic coated cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Double coated with a nominal 0.002-inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
      f. With a minimum 0.040-inch (40 mil) PVC coating bonded to exterior.
      g. With pressure sealing sleeve to protect the connection with conduit.

D. Explosionproof enclosures:
   1. Dual rated NEMA Type 9 and NEMA Type 4X.
   2. Cast iron box and cover.
   3. Precision machined flame path between box and cover with O-ring.
   4. Cast-in-place or bolt-on stainless steel slotted mounting feet for horizontal or vertical mounting.
   5. For applications requiring hinged cover, provide flexible hinge mounting either left or right side.
   6. External flange.
   7. Provisions for mounting pan.
   8. Stainless steel cover bolts and hardware.
   9. Ground lug.

E. Formed steel enclosures:
   1. Steel:
      a. NEMA Type 12.
      b. Fabricated from 14-gauge steel, minimum.
      c. Seams continuously welded ground smooth.
      d. Door:
         1) Rolled lip around 3 sides.
         2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
      e. Neoprene door gasket to provide a watertight, dusttight, oiltight seal:
         1) Attached with an adhesive.
         2) Retained by a retaining strip.
      f. Fabricate external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel:
         1) With a hasp and staple for padlocking.
      g. Provide large enclosures with door and body stiffeners for extra rigidity.
      h. No holes or knockouts.
      i. Finish:
         1) ANSI 61 gray electrostatically applied polyester powder inside and out over cleaned and primed surfaces.
         2) White electrostatically applied polyester powder mounting plate.
      j. Heavy gauge steel external mounting brackets when surface mounted.
   2. Stainless steel:
      a. NEMA Type 4X:
         1) Boxes in locations subject to flooding or temporary submersion:
            a) NEMA Type 6.
      b. Fabricated from 14-gauge Type 316 stainless steel.

c. Seams continuously welded.
d. Door:
 1) Rolled lip around 3 sides.
 2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
e. Neoprene door gasket to provide a watertight seal:
 1) Attached with an adhesive.
 2) Retained by a retaining strip.
f. Fabricate external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
 1) With a hasp and staple for padlocking.
g. Provide large enclosures with door and body stiffeners for extra rigidity.
h. No holes or knockouts.
i. Finish:
 1) Brushed.
j. Stainless steel external mounting brackets when surface mounted.

F. Cast iron junction boxes:
1. NEMA Type 4.
2. Recessed cover boxes.
3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
4. Designed for flush mounting in walls or floors:
 a. Can be surface mounted using mounting lugs.
5. Construction:
 a. Cast iron box.
 b. Covers:
  1) Checkered plate covers suitable for foot traffic.
  2) When used in areas subject to vehicular traffic, design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading.
 c. Hot dip galvanized.
 d. Neoprene gasket.
 e. Stainless steel screw covers.

**2.06 EQUIPMENT (NOT USED)**

**2.07 COMPONENTS (NOT USED)**

**2.08 ACCESSORIES**

A. Fasteners:
1. Electroplated or stainless steel in boxes with wiring devices.
2. Screws, nuts, bolts, and other threaded fasteners:
 a. Stainless steel.

B. Provide breather and drain fittings where appropriate.

C. Internal panels:
1. Provide internal panels where required for mounting of terminal strips or other equipment.
2. With plated steel shoulder studs.

3. Steel with white polyester powder finish.

D. Floor stand kit when shown:
1. Fabricated from 12-gauge steel.
2. Bottom plate 11-gauge.
3. Heights:
   a. 12 inches.
4. Do not provide external mounting brackets, when a floor stand kit is used.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. General:
1. Provide outlet box materials to match the conduit system:
   a. GRC - Cast ferrous boxes.
   b. PCS - PVC coated cast ferrous boxes.
2. Solid type gang boxes:
   a. For more than 2 wiring devices.
   b. For barriered outlets.
3. Support wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8-inch free air space between the back of the enclosure and the wall:
   a. Use machined spacers to maintain air space; built-up washers are not acceptable.
   b. Use stainless steel or nylon materials for spacers.
4. Use cast malleable iron boxes when box must support other devices.
5. Boxes serving luminaires or wiring devices:
   a. Use as pullboxes wherever possible.
6. Fit cast boxes and pressed steel boxes for flush mounting in concrete with cast, malleable box covers and gaskets.
7. In terminal boxes, furnish terminals as indicated on the Drawings with a minimum of 50 percent spare terminals:
   a. Furnish wireways for discrete and analog/DC wiring.
   b. Separate analog wiring from 120 V discrete or power wiring.
8. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.

B. Outlet boxes:
1. Locate outlet boxes as indicated on the Drawings:
   a. Adjust locations so as not to conflict with structural requirements or other trades.
2. Use deep threaded-hub malleable iron boxes:
   a. In hazardous areas.
   b. Where exposed to the weather.
   c. In unheated areas.

d. Where subject to mechanical damage:
   1) Defined as exposed boxes less than 10 feet above the floor.
e. To act as a pullbox for conductors in a conduit system.
f. Accommodate wiring devices.

3. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the exposed conduit system is PVC coated steel.
4. Outlet boxes may be used as junction boxes wherever possible.

C. Pullboxes and junction boxes:
1. Install pullboxes such that access to them is not restricted.
2. Outlet, switch, and junction boxes for flush mounting in general purpose locations:
   a. One-piece, galvanized, pressed steel.
3. Outlet, switch, and junction boxes where surface mounted in exposed locations:
   a. Cast ferrous boxes with mounting lugs, zinc or cadmium plating finish.
4. Outlet, control station, and junction boxes for installation in corrosive locations:
   a. Fiberglass reinforced polyester, stainless steel, or plastic-coated steel to match the conduit system.
   b. Furnished with mounting lugs.
5. Fire rated construction: Use materials and methods to comply with the listing requirements for the classified construction.

D. Recessed boxes:
1. Support recessed boxes in suspended ceilings or stud partitions with galvanized steel box hangers of types made specifically for the purpose or attach directly to wood members or blocking.
2. Secure hangers or boxes to wood with 1-inch-long cadmium-plated Type A pan head screws:
   a. Fully or partially hammer-driven screws are not acceptable.

E. Hazardous locations:
1. Class II Division 1 areas:
   a. Provide boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
      1) Approval ratings must be permanently marked on each item.
2. Class II Division 2 areas:
   a. For boxes not containing arcing parts:
      1) As specified in Section 16050 - Common Work Results for Electrical.
      2) Pressed metal boxes are not allowed.
   b. For boxes containing arching parts provide:
      1) Boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
         a) Approval ratings must be permanently marked on each item.
3. Metallic boxes, fittings, and joints shall utilize threaded connections to the conduit system.
4. Threaded connections shall be wrench tightened so that at least 5 threads are fully engaged.
5. Conduits entering and exiting metallic boxes in Class II Division 2 areas shall utilize approved grounding bushings to bond the conduits together.

6. Provide the following types of conduit bodies and boxes:
   a. Malleable iron bodies and boxes with GRC or IMC conduit systems.
   b. PVC coated conduit bodies and boxes with PCS conduit systems.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

## SECTION 16140

## WIRING DEVICES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
  1. Switches.
  2. Receptacles.
  3. Plates.

### 1.02 REFERENCES

A. Federal Specifications (FS):
  1. W-C 596 - Connector, Electrical, Power, General Specification for.
  2. W-S 896/2 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

B. National Electrical Manufacturers Association (NEMA):
  1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

C. Telecommunications Industry Association (TIA):
  1. T568A - Eight-position jack pin/pair assignment.
  2. T568B - Optional eight-position jack pin/pair assignment.

D. Underwriters Laboratories, Inc. (UL):
  1. 20 - General Use Snap Switches.
  2. 498 - Standard for Attachment Plugs and Receptacles.
  3. 943 - Ground-Fault Circuit-Interrupters.

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
  1. GFCI: Ground fault circuit interrupter.

### 1.04 DELEGATED DESIGN (NOT USED)

### 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
  1. Catalog cutsheets.

C. Shop Drawings:
  1. Engraving schedule:
    a. Furnish complete engraving schedule for engraved nameplates.

## 1.06 QUALITY ASSURANCE

A. Wiring devices shall be UL listed and labeled.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Switches, receptacles, and plates as indicated on the Drawings, wired and operable to form a complete system.

## 2.03 MANUFACTURERS

A. Switches:
   1. One of the following or equal:
      a. Cooper Wiring Devices.
      b. Hubbell.
      c. Leviton.
   2. Switches for hazardous areas:
      a. One of the following or equal:
         1) Appleton.
         2) Crouse-Hinds.
   3. Occupancy sensor switches:
      a. One of the following or equal:
         1) Cooper Wiring Devices.
         2) WattStopper.
   4. Dimmer switches:
      a. One of the following or equal:
         1) Cooper Wiring Devices.
         2) Lutron.

B. Receptacles:
   1. General purpose:
      a. One of the following or equal:
         1) Cooper Wiring Devices.
         2) Hubbell.

3) Leviton.

2. Hazardous areas:
   a. One of the following or equal:
      1) Appleton.
      2) Crouse-Hinds.

C. Plates:
   1. General location:
      a. One of the following or equal:
         1) Cooper Wiring Devices.
         2) Legrand.
   2. Wet or corrosive areas:
      a. One of the following or equal:
         1) ABB.
         2) Cooper Wiring Devices.
         3) Hubbell.
         4) Pass and Seymour.
   3. In-use covers:
      a. One of the following or equal:
         1) ABB.
         2) Cooper Wiring Devices.
         3) Pass and Seymour.
         4) TayMac.

D. Data and communications jacks:
   1. Network jacks:
      a. One of the following or equal:
         1) Belden; REVConnect Connectivity System.
         2) Hubbell.
         3) Leviton; Quickport series.
         4) Panduit.
   2. Wall plates:
      a. One of the following or equal:
         1) Belden; REVConnect Connectivity System.
         2) Leviton; Quickport series.
         3) Optical Cable Corporation (OCC).
         4) Panduit.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS

A. Switches:
   1. General:
      a. 120 to 277 VAC.
      b. 20-amp.
      c. Listed in accordance with UL 20.
      d. Designed and constructed in accordance with FS W-S-896/2.
      e. Back and side wired unless otherwise indicated.
      f. Integral grounding terminal.

g. Totally enclosed:
    1) Color-coded body with color corresponding to amp rating.
h. Provide switches with the operator style and contact arrangement as indicated on the Drawings and as required for proper operation.
i. Color:
    1) White in finished areas.
    2) White in all other areas.

2. General purpose switches:
    a. Toggle type.
3. Switches for office areas:
    a. Rocker type.
    b. Rectangular.
4. Switches for use with photocell:
    a. Maintained contact.
    b. 2 circuit.
    c. 3 position:
        1) Center off.
5. Switches for hazardous areas:
    a. Suitable for use in Class II Division 1 and Class II Division 2 locations.
    b. Factory sealed.
    c. Through-feed or dead-end as required.
6. Occupancy sensor switches:
    a. Wall switch with dual-technology passive infrared and ultrasonic sensor.
        1) Configured such that lights turn on only when both infrared and ultrasonic sensors detect activity, but do not turn off as long as either sensor detects activity.
    b. Selectable “automatic-on” mode activated by sensors or “manual-on” mode activated by pushbutton.
    c. Adjustable 5- to 30-minute time delay.
    d. Selectable audible alert as a warning before lights turn off.
    e. Rated for fluorescent lighting loads of up to 800 W.
    f. True multi-way switching allowing identical controls at any location for multi-way switching applications.
7. Dimmer switches:
    a. Shall be rectangular design with LED light level indicators.
    b. Suitable for use with type of lamp switched.

B. Receptacles:
1. General purpose receptacles:
    a. Single or duplex as indicated on the Drawings.
    b. 125 VAC.
    c. 20 amp or as indicated on the Drawings.
    d. NEMA Type 5-20R configuration for 20 amp receptacles.
    e. Other NEMA configurations as indicated on the Drawings.
    f. Listed in accordance with UL 498.
    g. Designed and constructed in accordance with FS W-C-596.
    h. Back and side wired.
    i. 1-piece, rivet-less mounting strap.
    j. Color:
        1) White in finished areas.
        2) White in all other areas.

3) Red when powered by a UPS.

2. Ground fault interrupter receptacles (GFCI):
   a. 125 VAC.
   b. 20 amp.
   c. Trip level 4 to 6 mA.
   d. Individual and feed through protection.
   e. UL 943 and UL 498 listed.
   f. NEMA Type 5-20R configuration.
   g. For damp or wet locations:
      1) Weather resistant, in accordance with UL 498.
3. Receptacles for hazardous areas:
   a. 125 VAC.
   b. 20 amp.
   c. Factory sealed.
   d. Single receptacle.
   e. 2-wire, 3-pole.
   f. Grounded through extra pole and shell.
   g. Dead-front construction.
   h. Interlocked to prevent plug from being withdrawn until circuit has been broken.

C. Plates:
1. General location:
   a. Type 302 or 304 stainless steel.
   b. Brushed satin finish.
   c. Minimum thickness: 0.032 inches.
   d. Rectangular or square shape.
   e. Engraving:
      1) Engrave each switch plate with the following:
         a) Area served.
         b) Panelboard and Circuit.
      2) Engrave each receptacle plate with the following:
         a) Panelboard and Circuit.
      3) Treat engraving to improve visibility.
      4) Characters shall be block letter pantograph engraved with a minimum character height of 1/8-inch.
   f. Coordinate the number of gangs, number, and type of openings with the specific location.
2. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures:
   a. General:
      1) UL listed for wet locations.
      2) Gasketed.
      3) Die cast metal:
         a) Match material to box material.
   b. Switches:
      1) Lever operated:
         a) Provide toggle switch.
   c. Receptacles:
      1) Weatherproof in-use cover:
         a) Die cast metal construction with electrostatic powder coating for corrosion resistance.

b) Gasketed.
c) Lockable.
d) UL listed and in accordance with NEC.

3. Corrosive areas:
   a. Neoprene.
   b. Gasketed.
   c. Weatherproof.

D. Data and communications jacks:
   1. Process network jacks - conduit body mounted:
      a. Network jacks located in process areas shall have a NEMA Type 4 rating (with closure cap).
      b. Mounting of network jacks in conduit bodies adapter (with minifast connector) shall be accomplished using conduit body insert and environmental enclosure caps.
      c. PC board connections are not to be allowed.
      d. Furnish 10 RJ-45 to minifast connector patch cable 3 feet in length.
      e. Manufacturers: The following or equal:
         1) InterlinkBT.
   2. Network/phone jacks:
      a. Meets or exceeds TIA standards for the Category of Ethernet cable connected.
      b. Accommodates TIA T568A and TIA T568B wiring schemes.
      c. UL listed or rated.
      d. Provide different colors for each network unless otherwise indicated on the Drawings.
      e. Power over Ethernet up to 100 watts.
      f. Interchangeable icons to identify function.
      g. Shall comply with NEC requirements.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. Mounting heights:
   1. Process and production areas:
      a. Switches and receptacles 48 inches from finished floor to top of plate.
   2. Offices and finished areas:
      a. Switches: 48 inches from finished floor to top of plate.
      b. Receptacles: 18 inches from finished floor to center of plate.

B. Switches:
   1. Over 300 volts:
      a. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.

2. Terminate wires under back wire clamps. Do not wrap wires around the screws.

C. Receptacles:
1. Provide GFCI receptacles as indicated on the Drawings.
   a. Provide weather resistant GFCI receptacles in wet or damp areas.
2. Mount receptacles vertically:
   a. Ground slot down.
3. 3-phase receptacles shall be consistent with respect to phase connection at the receptacle terminals. Correct errors in phasing at the source and not the receptacle.
4. Terminate wires under back wire clamps. Do not wrap wires around the screws.

D. Ensure plates make a firm seal with wall for recessed mounted devices:
1. Outside edges of plates parallel with building lines.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

## SECTION 16150

## LOW VOLTAGE WIRE CONNECTIONS

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Wire connecting devices.
   2. Terminations.
   3. Splices.
   4. Power distribution blocks.

## 1.02 REFERENCES

A. ASTM International (ASTM):
   1. D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

B. CSA International (CSA):
   1. C22.2 - No. 197-M1983 (R2208) - PVC Insulating Tape.

C. Underwriters Laboratories, Inc. (UL):
   1. 486A-B - Standard of Safety for Wire Connectors.
   2. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   3. 1953 - Outline of Investigation for Power Distribution Blocks.

## 1.03 DELEGATED DESIGN (NOT USED)

## 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Installation instructions.

## 1.05 QUALITY ASSURANCE

A. Materials shall be UL listed.

## 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for the Engineer's review.
   2. After successful review of the initial fault current study, submit complete equipment submittal.

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide a complete system of wiring connectors, terminators, fittings, etc., for a complete wiring system suitable for the cables and conductors used.

## 2.03 MANUFACTURERS

A. Manufacturers for each type of technology are specified with the equipment in this Section.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Control connections:
   1. Use insulated ring type wire terminators for connections to screw terminals:
      a. With chamfered/funneled terminal barrel entry.
      b. Deep internal serrations.
      c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.
      d. Electroplated-tin copper conductor.
      e. Manufacturers: The following or equal:
         1) ABB, Sta-Kon.
   2. For process equipment connections, work from manufacturer's drawings.

B. Joints, splices, taps, connections, and terminations:
   1. 600-volt conductors:
      a. Use solderless connectors.
      b. Copper pigtail adaptors.
         1) For use on select applications as approved by the Engineer.
         2) 600 volt, 90 degrees Celsius rated.

3) UL 486A/B listed.
4) Manufacturers: The following or equal:
   a) Burndy APY series.
   b) ILSCO CPM series.

c. Use only plated copper alloy connectors or lugs:
   1) Aluminum connectors or lugs are not acceptable for copper conductors.

d. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.

e. For wire Number 10 AWG and smaller, use compression splice caps, with insulating caps:
   1) Manufacturers: The following or equal:
      a) Buchanan, 2006S or 2011S, with 2007 or 2014 insulating caps.

f. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
   1) Manufacturers: One of the following or equal:
      a) ABB.
      b) Burndy.

g. Heat shrink tubing:
   1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
   2) Minimum shrink ratio: 4 to 1.
   3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
   4) Internally applied adhesive sealant.
   5) Cross-linked polyolefin:
      a) Manufacturers: One of the following or equal:
         (1) 3M, ITCSN.
         (2) ABB, Shrink-Kon.

2. Instrumentation class cable splices:
   a. Suitable for indoor, outdoors, weather exposed, direct buried, or submersed applications.
   b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
   c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kilovolt.
   d. Two-part mold body with tongue and groove seams and built-in spacer webbing.
   e. Manufacturers: The following or equal:
      1) 3M, Scotchcast 72-N.

C. Insulating tape:
   1. General purpose insulating tape:
      a. Minimum 7 mil vinyl tape.
      b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
      c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
      d. Flame retardant, hot- and cold-weather resistant, UV resistant.
      e. For use as a primary insulation for wire cable splices up to 600 VAC.
      f. Meeting and complying with:
         1) ASTM D3005 Type I.

2) UL 510.
3) CSA C22.2.

g. Manufacturers: The following or equal:
    1) 3M, Scotch Number Super 33+.

2. General purpose color-coding tape:
    a. Minimum 7 mil vinyl tape.
    b. Suitable for application on PVC and polyethylene jacketed cables.
    c. For use indoors and outdoors in weather protected enclosures.
    d. Available with the following colors:
        1) Red.
        2) Yellow.
        3) Blue.
        4) Brown.
        5) Gray.
        6) White.
        7) Green.
        8) Orange.
        9) Violet.
    e. For use as phase identification, marking, insulating, and harnessing.
    f. Meeting and complying with:
        1) UL 510.
        2) CSA C22.2.
    g. Manufacturers: The following or equal:
        1) 3M, Scotch Number 35.

D. Power distribution blocks:
    1. UL 1953 listed.
    2. Short circuit rating: Not less than the system maximum available fault current at the point of application.
    3. Provide fuses or circuit breakers in enclosure as required to meet the fault current requirements.
    4. Voltage rating: 600 VAC.
    5. IP 20 finger safe enclosure.
    6. Tin-plated aluminum or copper terminals suitable for copper conductors.
    7. Manufacturers: One of the following or equal:
        a. Eaton CHDB series.
        b. Rockwell Automation 1492 PD series.
        c. Schneider Electric LB series.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. Load connections:
    1. Connect loads to the circuits as indicated. Color-code branch circuits as specified in Section 16123 - 600-Volt or Less Wires and Cables.

B. Zero to 600-volt systems:
   1. Make connections with the proper tool and die as specified by the device manufacturer.
   2. Use only tooling and dies manufactured by the device manufacturer.
   3. Insulate connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
   4. Number power and control wires before termination.

C. Motor connections (600 volts and below):
   1. Terminate leads and wires with compression type ring lugs.
   2. Terminations on motor leads, including leads that are connected together to accommodate the motor voltage, and the machine wires entering the motor terminal box from the power source, shall have ring type compression lugs.
   3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
      a. In damp and wet locations, use a complete kit containing mastic that shall seal out moisture and contamination.
      b. Shrink cap with low heat as recommended by the manufacturer.
   4. Wire markers shall be readable after boot installation.
   5. Manufacturers: The following or equal:
      a. Raychem, MCK.

D. Power distribution terminal blocks:
   1. Connect fuses or circuit breakers on the line side of power distribution terminal blocks as required to meet short circuit requirements.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

## SECTION 16151

## MEDIUM VOLTAGE CABLE CONNECTIONS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Terminations.
   2. Splices.
   3. Junctions.

### 1.02 REFERENCES

A. Abbreviations:
   1. BIL - Basic insulation level.

B. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE):
      a. 48 - IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
      b. 386 - Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
      c. 404 - IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV.
   2. Underwriters Laboratories, Inc. (UL).

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Installation instructions.
   3. Medium voltage systems:
      a. Documentation demonstrating compliance with the required tests.
      b. Characteristics and installation procedures for splices, terminators, and junction modules.

C. Shop Drawings:
   1. Showing the installation of splices, terminators, and junction modules.

D. Operation and maintenance manuals:
   1. Drawings and data for medium voltage cable connectors, splices, terminators, and junction modules.

## 1.05 QUALITY ASSURANCE

A. Materials shall be UL listed where applicable.

## 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide a complete system of cables, connectors, terminators, fittings, etc., for a complete cabling system suitable for the cables and conductors used.

## 2.03 MANUFACTURERS

A. Manufacturers for each type of technology are specified with the equipment in this Section.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Tape:
   1. Fire and electric arc proofing tape:
      a. Minimum 30-mil, flexible, elastomer tape that expands in fire to form an insulating firewall between flame and cable.
      b. Bind in place with glass cloth electrical tape.
      c. Manufacturers: The following or equal:
         1) 3M, Scotch Number 77.
   2. Glass cloth electrical tape:
      a. Thermosetting, 7.4-mil silicone adhesive that performs at Class H temperatures 180 degrees Celsius (356 degrees Fahrenheit).

b. Use for the following applications:
    1) To secure non-PSA insulations such as glass in high-temperature areas.
    2) Splice wire rated at 150 degrees Celsius, 180 degrees Celsius, and 200 degrees Celsius.
    3) For binding fire and electric arc proofing tape.
c. Meeting and complying with:
    1) UL recognized component listing for 200 degrees Celsius (Guide OANZ2, File E17385).
d. Manufacturers: The following or equal:
    1) 3M, Scotch Number 69.

3. Self-fusing silicone rubber tape:
    a. High-temperature, 12-mil, track resistant, insulating tape.
    b. Composed of fully cured inorganic silicone rubber.
    c. Use as a protective overwrap for terminating medium voltage cables.
    d. Manufacturers: The following or equal:
        1) 3M, Scotch Number 70.

B. Lugs:
    1. Tin-plated copper.
    2. Compression type.
    3. 2-hole blade.
    4. UL listed.

C. Cable splices and terminations:
    1. Cold shrink splices:
        a. Permanent in-line cold shrink splice.
        b. Suitable for submersible, direct burial applications.
        c. Splice body shall be a pre-expanded one-piece molded cold shrink design of silicone rubber with spiral holdout. Splice shall be covered with a cold shrink jacket tube made of EPDM rubber for physical protection.
        d. Electrical requirements:
            1) Continuous current rating equal to cable.
            2) 5 to 8 kV voltage class:
                a) Voltage rating phase-ground: 4.6 kV-rms.
                b) Minimum partial discharge voltage (less than 3 pC): 7 kV-rms.
                c) AC withstand, 1 minute: 23 kV-rms.
                d) AC withstand, 5 minutes: 21 kV-rms.
                e) AC withstand, 5 hours: 16 kV-rms.
                f) DC withstand, 15 minutes: 45 kV.
                g) Impulse withstand, 1.2 by 50 microseconds: 95 kV (crest).
            3) 15 kV voltage class:
                a) Voltage rating phase-ground: 8.7 kV-rms.
                b) Minimum partial discharge voltage (less than 3 pC): 13 kV-rms.
                c) AC withstand, 1 minute: 35 kV-rms.
                d) AC withstand, 5 minutes: 39 kV-rms.
                e) AC withstand, 5 hours: 31 kV-rms.
                f) DC withstand, 15 minutes: 70 kV.
                g) Impulse withstand, 1.2 by 50 microseconds: 110 kV (crest).
        e. Power cable splices for shielded solid dielectric plastic-insulated cables shall utilize factory-engineered kits containing necessary components to

maintain primary cable insulation level and metallic shielding/grounding systems.

f. Splice shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances. When assembled on cables the splice shall be capable of passing the electrical test in accordance with:
   1) IEEE 48.
   2) IEEE 404.
g. Manufacturers: One of the following or equal:
   1) 3M.
   2) Prysmian Group.
   3) TE Connectivity/Raychem.

2. Live front terminators (cold shrink):
   a. Terminators for shielded solid dielectric plastic-insulated cables shall utilize factory-engineered kits containing necessary components to terminate the primary cables and shield systems.
   b. All locations exterior of buildings shall be considered outdoors, and appropriate heat-shrinkable skirts of a non-tracking material shall be installed.
   c. Of a material that will relieve the voltage stresses at the point of termination.
   d. Non-tracking.
   e. Ultraviolet resistant.
   f. Terminator insulation shall be of a uniform cross-section heat-shrinkable polymeric construction with a linear stress relief system.
   g. Electrical requirements:
      1) Continuous current rating equal to cable.
      2) 5 to 8 kV voltage class:
         a) Minimum partial discharge voltage (less than 3 pC) 9 kV.
         b) AC withstand, 1 minute: 35 kV.
         c) DC withstand, 15 minutes: 65 kV.
         d) Impulse withstand, 1.2 by 50 microseconds (outdoor): 95 kV (crest).
         e) Impulse withstand, 1.2 by 50 microseconds (indoor): 80 kV (crest).
         f) Wet withstand, 10 seconds: 30 kV rms.
         g) Dry withstand, 6 hours: 25 kV rms.
      3) 15 kV voltage class:
         a) Minimum partial discharge voltage (less than 3 pC) 13 kV.
         b) AC withstand, 1 minute: 50 kV.
         c) DC withstand, 15 minutes: 75 kV.
         d) Impulse withstand, 1.2 by 50 microseconds (outdoor): 110 kV (crest).
         e) Impulse withstand, 1.2 by 50 microseconds (indoor): 95 kV (crest).
         f) Wet withstand, 10 seconds: 45 kV rms.
         g) Dry withstand, 6 hours: 35 kV rms.
   h. Terminator kit shall accommodate a range of cable sizes and be completely independent of cable manufacturer's tolerances. When assembled on cables the terminator shall be capable of passing the electrical test in accordance with:
      1) IEEE 48.

i. Manufacturers: One of the following or equal:
    1) 3M.
    2) Burndy/Hubbell Power Systems.
    3) Prysmian Group.
    4) TE Connectivity/Raychem.

3. Dead front terminators (600 amps):
    a. Terminators for shielded solid dielectric plastic-insulated cables shall be factory-engineered kits containing necessary components to terminate the primary cables and shield systems.
    b. Modular, pre-molded, fully shielded dead front system.
    c. Submersible.
    d. Capable of mating with any manufacturer’s interface in accordance with IEEE 386.
    e. Crimp connector suitable for copper conductors using standard compression tools to join the conductor to the interface.
    f. To be used as an elbow or a “T”.
    g. Cable stress relief adapters to connect the cable insulation to the dead front terminator.
    h. Heat shrink seal over the junction between the cable insulation and the terminator body.
    i. Conductor shield shall be grounded near the termination and connected to the conductive shield of the terminator.
    j. Bolted to the bushing or connector plug, with an insulating plug to cover the connection.
    k. Conductive cap covering the insulating plug.
    l. Conductive shield to provide reliable continuity between jacket of cable and connector.
    m. Conductive insert around connector to prevent corona.
    n. With a capacitive test point on the insulating plug to allow circuit testing without disturbing the connection.
    o. Electrical requirements:
        1) Voltage class: 15 kV:
            a) Maximum voltage:
                (1) Phase to Ground: 8.3 kV rms.
                (2) Phase to Phase: 14.4 kV rms.
            b) Withstand voltage:
                (1) Impulse (1.2 by 50 microseconds): 95 kV (crest).
                (2) AC 1 minute: 34 kV.
                (3) DC 15 minutes: 53 kV.
            c) Minimum corona extinction level:
                (1) 11 kV rms.
            d) Continuous current rating:
                (1) 600 amps rms.
            e) Momentary rating:
                (1) 25,000 amps rms at 0.17 seconds.
                (2) 10,000 amps rms at 3.0 seconds.
    p. Manufacturers: One of the following or equal:
        1) 3M.
        2) ABB/Elastimold.
        3) Eaton/Cooper.

4. Dead front terminators (200 amps):
    a. Terminators for shielded solid dielectric plastic-insulated cables shall be factory-engineered kits containing necessary components to terminate the primary cables and shield systems.
    b. Modular, pre-molded, fully shielded dead front system.
    c. Loadbreak type.
    d. Submersible.
    e. Capable of mating with any manufacturer's interface in accordance with IEEE 386.
    f. Crimp connector suitable for copper conductors using standard compression tools to join the conductor to the interface.
    g. To be used as an elbow or a "T".
    h. Heat shrink seal over the junction between the cable insulation and the terminator body.
    i. Conductor shield shall be grounded near the termination and connected to the conductive shield of the terminator.
    j. Conductive shield to provide reliable continuity between jacket of cable and connector.
    k. Conductive insert around connector to prevent corona.
    l. With a capacitive test point with protective cover to allow circuit testing without disturbing the connection.
    m. Electrical requirements:
        1) Voltage class 15 kV.
        2) Withstand voltage:
            a) Impulse (1.2 by 50 microseconds): 95 kV (crest).
            b) AC 1 minute: 34 kV.
            c) DC 15 minutes: 53 kV.
        3) Minimum corona extinction level:
            a) 11 kV rms.
        4) Continuous current rating:
            a) 200 amps rms.
        5) Momentary rating:
            a) 10,000 amps rms, symmetrical at 0.17 seconds.
            b) 3,500 amps rms, symmetrical at 3.0 seconds.
    n. Manufacturers: One of the following or equal:
        1) 3M.
        2) ABB/Elastimold.
        3) Eaton/Cooper.

D. Insulated protective cap:
1. Cap unused bushings/taps to electrically insulate and mechanically seal taps with an insulating cap.
    a. Loadbreak type.
    b. Submersible.
2. Fully compliant with IEEE 386.
    a. Electrical requirements:
        1) Voltage class 15 kV.
        2) Withstand voltage:
            a) Impulse (1.2 by 50 microseconds): 95 kV (crest).
            b) AC 1 minute: 34 kV.
            c) DC 15 minutes: 53 kV.

3) Minimum corona extinction level:
    a) 11 kV rms.
b. Manufacturers: One of the following or equal:
    1) 3M.
    2) ABB/Elastimold.
    3) Eaton/Cooper.
    4) Hubbell Power Systems.

E. Insulated standoff bushings:
1. Rated for 200 amps.
2. Loadbreak type.
3. Submersible.
4. Fully compliant with IEEE 386.
    a. Electrical requirements:
        1) Voltage class 15 kV.
        2) Withstand voltage:
            a) Impulse (1.2 by 50 microseconds): 95 kV (crest).
            b) AC 1 minute: 34 kV.
            c) DC 15 minutes: 53 kV.
        3) Minimum corona extinction level:
            a) 11 kV rms.
5. Molded EPDM rubber body with stainless steel base bracket.
6. Eyebolt for securing the bushing in a parking stand.
7. Ground lug.
8. Manufacturers: One of the following or equal:
    a. ABB/Elastimold.
    b. Eaton/Cooper.
    c. Hubbell Power Systems.

## 2.07 ACCESSORIES (NOT USED)

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION (NOT USED)

## 3.03 INSTALLATION

A. Medium voltage systems:
1. Ground shield at all terminators, splices, and junctions.
2. Install cable lugs, terminators, splices, and junctions in accordance with the manufacturer’s specifications.
3. Fireproof exposed portions of cables.
    a. Half-lapped layer of fire and electric arc proofing tape, secured with double-wrapped band of glass cloth electrical tape at each end.

B. Insulated standoff bushings:
1. Provide an insulated standoff bushing in dead-front transformer parking stand.

C. Medium voltage switchgear connections:
1. Tape or provide insulated boots on cable connections at medium voltage switchgear to maintain the switchgear BIL rating.
2. Make the connections in accordance with the manufacturer's guidelines.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

## SECTION 16222

## LOW VOLTAGE MOTORS UP TO 500 HORSEPOWER

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Low voltage motors up to 500 horsepower (hp).

### 1.02 REFERENCES

A. Standards:
   1. American Bearing Manufacturers Association (ABMA):
      a. 9 - Load Ratings and Fatigue Life for Ball Bearings.
      b. 11 - Load Ratings and Fatigue Life for Roller Bearings.
   2. ASTM International (ASTM):
      a. B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
   3. Institute of Electrical and Electronic Engineers (IEEE):
      a. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
      b. 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
      c. 303 - Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations.
      d. 841 - IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
   4. National Electrical Manufacturers Association (NEMA):
      a. MG-1 - Motors and Generators.
   5. Underwriters Laboratories Inc. (UL):
      a. 674 - Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Submit completed motor data sheets for each motor supplied:
   1. As specified in Attachment A - Motor Data Sheet.
   2. Manufacturer’s or other data sheets are not acceptable.

C. Product data:
   1. Descriptive bulletins.
   2. Machine tag and loop number as indicated on the Drawings and in the specification section number of the driven machine.

3. Complete electrical data.
4. Manufacturer's storage recommendations.
5. Torque, current, and power factor versus speed curves:
    a. At 100 percent rated voltage for full voltage started and VFD-driven motors.
    b. For motors on reduced voltage start at 70, 80, 90, and 100 percent rated voltage.
6. Additional data for motors installed in classified areas:
    a. Temperature code.
    b. Hazardous area approval indicating Class, Division, and Group:
        1) For motors driven by variable frequency drives, provide manufacturer's certification that the motor is suitable for operation in the hazardous area when driven by a variable frequency drive.
7. Accessories data:
    a. Power factor correction capacitors:
        1) Size in KVAR for motors not connected to variable frequency drives.
    b. Motor winding heaters:
        1) Voltage.
        2) Watts.
    c. Winding temperature detectors:
        1) Type.
        2) Rating.
    d. Moisture detectors.
8. Mechanical data:
    a. Bearing design and bearing life calculations.
    b. Resonant frequencies for VFD-driven motors 50 hp or greater.

D. Shop Drawings:
1. Motor weight.
2. Frame size.
3. Conduit box(es), size(s), and location(s).
4. Outline drawings with dimensions.
5. Installation details for the project seismic criteria.

E. Commissioning Submittals:
1. As specified in Section 01756 - Commissioning, including the following:
    a. Certificates:
        1) Requirements as specified in this Section.
    b. Test Plans:
        1) Test requirements as specified in this Section.
    c. Test Reports.

F. Test reports:
1. Factory test reports with test reference standard identified.

G. Certification:
1. When motors are driven by variable speed drive systems, submit certification that selected motor:
    a. Is capable of satisfactory performance under the intended load.
    b. Meets the requirements of the latest edition of NEMA MG-1 Part 31.

H. Calculations:
   1. Where site conditions specified in Section 01850 - Design Criteria exceed manufacturer's ratings, provide derating calculations for each motor.

## 1.05 QUALITY ASSURANCE (NOT USED)

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Store motors in accordance with the manufacturer's recommendations.

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Furnish and install electric motors and accessories as specified in this Section and the Sections specifying driven equipment to provide a complete and operable installation.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. Baldor.
   2. General Electric.
   3. Reliance.
   4. Toshiba.
   5. US Motors.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. 3-phase induction motors - general:
   1. Voltage:
      a. Motors 1/2 hp and larger shall be rated 460 V, 3-phase unless otherwise indicated on the Drawings.
      b. Dual voltage motors rated 230/460 V; 3-phase are acceptable provided all leads are brought to the conduit box.
   2. Motors driving identical machines shall be identical.
   3. Motors greater than 1 hp and up to 500 hp shall meet the NEMA Premium Efficiency percent listed in NEMA MG-1.
   4. Horsepower as indicated on the Drawings:
      a. Horsepower ratings indicated on the Drawings are based on vendor's estimates. Provide motors sized for the load of the actual equipment furnished without operating in the service factor.
   5. Service factor:
      a. 1.15 service factor on sine wave power.
      b. 1.0 when driven by VFD.
   6. Torque:
      a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
      b. When started using reduced voltage starters:
         1) Provide motors that develop sufficient torque for acceleration to full speed.
      c. NEMA Design B except where driven load characteristics require other than normal starting torque:
         1) In no case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
   7. Enclosures:
      a. As specified in the individual equipment Specifications or in this Section.
      b. Totally enclosed fan cooled:
         1) Cast iron conduit box.
         2) Tapped drain holes with Type 304 stainless steel plugs for frames 286 and smaller, and automatic breather and drain devices for frames 324 and larger.
      c. Explosion proof:
         1) Tapped drain holes with corrosion resistant plugs for frames 286 and smaller and automatic breather and drain devices for frames 324 and larger.
      d. Lifting devices: Motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
   8. Manufactured with cast iron frames in accordance with NEMA MG-1 or manufacturer's standard material for the specified rating.
   9. Nameplates:
      a. Provide motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
         1) NEMA standard motor data:
            a) Indicate compliance with NEMA MG-1 Part 31 for inverter duty motors.
         2) AFBMA bearing numbers and lubrication instructions.

10. Hardware:
    a. Type 304 stainless steel.
11. Conduit boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
        1) Frames and conduit boxes.
        2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90-degree increments:
        1) Where available based on the size of the conduit box.
    e. Exceeding the dimensions defined in NEMA MG-1.
    f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor bearings:
    a. Antifriction.
    b. Regreasable and initially filled with grease for horizontal motors and vertical motors per manufacturer’s standard design.
    c. Bearings and lubrication suitable for ambient temperature and temperature rise.
    d. Suitable for intended application and have a rate for ABMA 9 or 11, L-10 rating life of 60,000 hours or more.
    e. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
    f. Where specified in the equipment Specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.
13. Insulation systems:
    a. Motors installed in ambient temperatures 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius at the altitude where the motor will be installed.
    b. Motors installed in ambient temperatures between 40 degrees Celsius and 50 degrees Celsius:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 50 degrees Celsius at the altitude where the motor will be installed.
    c. Motors installed in ambient temperatures between 50 degrees Celsius and 65 degrees Celsius:
        1) Provide Class H insulation.
        2) Design temperature rise consistent with Class F insulation.
        3) Rated to operate at an ambient temperature of 65 degrees Celsius at the altitude where the motors will be installed.
14. Motor leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
    a. Maximum operating noise level in accordance with NEMA MG-1.

B. Submersible motors:
   1. Enclosures:
      a. Totally enclosed non-ventilated (TENV) watertight casing.
      b. Inner and outer shaft seals separated by an oil chamber.
   2. Cooling:
      a. Suitable for continuous operation in totally, partially, or nonsubmerged condition without overheating.
      b. Convection cooling by the surrounding environment or pump cooling by circulating a portion of the pumped media through a cooling water jacket as recommended by the manufacturer based on hp and application.
   3. Electrical cables:
      a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
      b. Epoxy encapsulated cable entry into terminal box.
   4. Insulation:
      a. Sealed moisture resistant windings.
      b. Class H.
   5. Motor protection:
      a. Provide temperature detection in motor windings.
      b. Provide moisture detection in motor housing.
      c. Other detection and protection functions specified in the in the driven equipment Section.

C. Vertical motors:
   1. Enclosures:
      a. Totally enclosed fan cooled (TEFC) for motors 200 hp and less installed outdoors.
      b. Weather protected Type II (WPII) for motors greater than 200 hp installed outdoors.
      c. Weather protected Type I (WPI) where installed indoors.
   2. Thrust bearings:
      a. Selected for combined rotor and driven equipment loads.
      b. Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.
   3. Anti-reverse ratchet.

D. Motors driven by variable frequency drives:
   1. Compatible with the variable frequency drives specified.
   2. Inverter duty rated and labeled.
   3. Meet the requirements of NEMA MG-1 Part 31.
   4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
   5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
   6. Shaft grounding ring:
      a. Provide a manufacturer-installed shaft grounding ring for each VFD-driven motor.
      b. Aluminum frame and internal components.
      c. Conductive microfiber brushes.
      d. Maintenance free design.
      e. Colloidal silver compound installed on shaft under the shaft grounding ring.
      f. High frequency ground strap.

g. Grounding ring:
   1) Installed inside motor housing on drive end (DE).
   2) Installed on exterior of motor housing on drive end with written permission from the Engineer.
h. Refer to the following table for specific requirements based upon the driven motor:

| Motor Size | <100 HP | 100 HP to 500 HP | >500 HP |
|---|---|---|---|
| Voltage | <600 VAC | <600 VAC | <600 VAC |
| AEGIS® Ring | SGR | SGR | PRO |
| Bearing Insulation | No | NDE | NDE & DE |
| Colloidal Sliver | Recommended | Required | Required |
| HF Grounding Straps | Required | Required | Required |

Notes:
DE - drive end.
HF - AEGIS® High Frequency Grounding Strap.
NDE - non-drive end.
PRO - AEGIS® PRO Series Shaft Grounding Rings.
SGR - AEGIS® Shaft Grounding Ring Series.

i. AEGIS® bearing protection ring, as manufactured by Electro Static Technology, or equal.

7. Insulated bearings:
   a. Provide motor manufacturer's standard insulated sleeve or ceramic bearings.
   b. Motors 100 hp to 500 hp: Provide insulated bearing on non-drive end (NDE) of the motor the end opposite the shaft grounding ring as recommended by the motor manufacturer.
   c. Motors larger than 500 hp: Provide insulated bearings on both the DE and NDE, and AEGIS® PRO Series shaft ground ring externally mounted on the DE.
8. Explosion proof motors:
   a. On motors less than or equal to 100 hp, provide insulated bearings on one end of the motor.
   b. On motors over 100 hp, provide insulated bearings on both ends of the motor.
   c. Shaft grounding ring:
      1) Installed inside the explosion proof enclosure in accordance with IEEE standard 303.

E. Motors installed in hazardous locations:
   1. Class I, Division 1 or Class II, Division 1 areas:
      a. Enclosures:
         1) Explosion proof for 3-phase motors.
         2) UL listed in conformance with UL 674.
         3) UL approval with nameplate and serial number.
   2. Other hazardous areas:
      a. Enclosures:
         1) TEFC for motors in Class I, Division 2 areas.
         2) Vertical motors as specified in this Section.

        3) Hazardous area and temperature code approval stamped on nameplate.
   3. Single-phase motors: Explosion proof motor enclosure.

F. Motors installed in corrosive environments:
   1. Nameplate indicating conformance to IEEE 841.
   2. Stator double dipped in varnish and baked.
   3. Stator and rotor coated with corrosion resistant epoxy.
   4. Frame, brackets, fan guard and conduit box coated with minimum of 2 coats of epoxy paint.
   5. Withstand salt spray tests in accordance with ASTM B117.

G. Single-phase motors:
   1. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or as indicated on the Drawings.
   2. Totally enclosed fan cooled (TEFC) motors manufactured in accordance with NEMA MG 1.
   3. Ball bearings: Sealed.
   4. 1/2 hp or less fan motors:
      a. Split-phase or shaded pole type when standard for the equipment.
      b. Open type when suitably protected from moisture, dripping water, and lint accumulation.
   5. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the Engineer.
   6. Integral overload protection.

H. Immersible motors:
   1. Meet all general requirements for 3-phase induction motors, except as modified in this Section.
   2. Inverter duty as indicated on the Drawings or in the driven equipment Specifications.
   3. Enclosure:
      a. Cast iron.
      b. Designed and constructed to meet or exceed IP67.
      c. Epoxy paint finish:
         1) Withstands salt spray and corrosion tests in accordance with ASTM B117.
      d. Furnished with lifting plates or lugs.
      e. Vertical or horizontal mounting as required by the application.
   4. Conduit box:
      a. Cast iron.
      b. Bolted and sealed cover.
      c. Rotatable in 90-degree increments.
      d. Watertight gland or potable hub for power cable entry.
   5. Power cable:
      a. Type SOOW or W cable, non-shielded.
      b. Length as required for the installation.

6. Cooling blower:
    a. As required by the motor manufacturer.
    b. Washdown duty rated.
    c. Constant speed.
7. Humidity moisture detector.

## 2.07 COMPONENTS (NOT USED)

## 2.08 ACCESSORIES

A. Motor winding heaters:
    1. Provide 3-phase motors with belted or cartridge space heaters mounted within the motor enclosure.
    2. Space heater rating shall be 120 volts, single-phase, unless otherwise indicated on the Drawings.
    3. Power leads for heaters wired into conduit box.
    4. Installed within motor enclosure adjacent to core iron.

B. Winding temperature detectors:
    1. Temperature switches with normally closed contacts as indicated on the Drawings.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION (NOT USED)

## 3.03 INSTALLATION

A. Install motors in accordance with manufacturer’s instructions.

B. Install shaft grounding ring on VFD-driven motors in accordance with the manufacturer’s instructions.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
    1. Motors less than 250 hp:
        a. Perform manufacturer’s standard production tests, including, but not limited to:
            1) No load current.
            2) High potential test.
            3) Winding resistance.
        b. Furnish copies of standard test reports on prototype or identical units.
    2. Motors 250 hp and larger:
        a. Perform tests in accordance with IEEE 112 or IEEE 43.
        b. Tests shall include the following:
            1) Winding resistance (cold).
            2) Locked rotor test.

3) Temperature rise test.
4) Load test.
5) Breakdown torque test.
6) No-load test.
7) High-potential test.
8) Insulation resistance test.
9) Vibration test in accordance with NEMA MG-1.
10) Polarization index.
11) Speed-torque curve.
12) Shaft voltage.
13) Bearing insulation resistance.
14) Efficiency and power factor versus load test performed at rated speed and 50 percent, 75 percent, 90 percent, and 100 percent of rated load. Curves from the motor tests shall be submitted for information.
15) Maximum allowable residual unbalance in each correction plane (journal) shall be calculated using the following equation:

    U = 4 W/N

    where:

    U = residual correction plane unbalance, in ounces-inches
    W = static correction plane journal loading, in pounds
    N = maximum specified operating speed, in revolutions per minute

c. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Functional Testing:
1. As specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL

A. Before start-up, perform insulation resistance test on each motor furnished or installed on this project:
1. Windings energized to 1,000 volts DC for 1 minute.
2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
3. Inform the Engineer of any unusual or unacceptable test results.
4. This test is in addition to the acceptance tests in Section 16950 - Field Electrical Acceptance Tests.

END OF SECTION

## ATTACHMENT A - MOTOR DATA SHEET

# MOTOR DATA SHEET

MOTOR/ EQUIPMENT TAG ______________________ MOTOR NUMBER ______________

SPECIFICATION NUMBER OF DRIVEN MACHINE ______________________

## MOTOR NAMEPLATE DATA

MANUFACTURER __________ MODEL/SERIES __________ MODEL NO. __________

FRAME __________ ENCLOSURE __________ NEMA DESIGN __________

HP __________ SERVICE FACTOR __________ RPM __________

INSULATION CLASS __________ VOLTS __________ FULL LOAD AMPS __________

AMBIENT TEMP __________ PHASE __________ NO LOAD AMPS __________

DESIGN TEMP __________ HERTZ __________ LOCK ROTOR AMPS __________

INRUSH CODE LETTER __________

| | 100% LOAD | 75% LOAD | 50% LOAD |
|---|---|---|---|
| GUARANTEED MINIMUM EFFICIENCIES: | __________ | __________ | __________ |
| GUARANTEED MINIMUM POWER FACTOR: | __________ | __________ | __________ |

MAXIMUM SIZE OF POWER FACTOR CORRECTION CAPACITOR: __________ KVAR

## ACCESSORIES

MOTOR WINDING HEATER __________ VOLTS __________ WATTS

WINDING THERMAL PROTECTION:

WINDING TEMP SWITCHES (YES/NO) __________

RTD:

TYPE __________ QUANTITY PER PHASE __________ # OF WIRES __________

NOMINAL RESISTANCE __________ NOMINAL TEMP __________ COEFFICIENT __________

RECOMMENDED ALARM ______ DEGREES CELSIUS RECOMMENDED TRIP ______ DEGREES CELSIUS

## SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO) ____ PART WINDING (YES/NO) ____ WYE - DELTA (YES/NO) ____

2 SPEED, 1 WINDING (YES/NO) ______ 2 SPEED, 2 WINDING (YES/NO) ______

AREA CLASSIFICATION:

CLASS __________ DIVISION __________ GROUP __________ TEMP CODE __________

* Conforms to NEMA MG-1 Part 31.

## SECTION 16235

## SINGLE SPARK-IGNITED GENERATOR SET

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Packaged automatic “standby” spark-ignited engine generator systems.

## 1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard.
   2. ASTM International (ASTM):
      a. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   3. International Fire Code.
   4. National Electrical Manufacturers Association (NEMA):
      a. MG-1 - Motor and Generators.
   5. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).
      b. 110 - Standard for Emergency and Standby Power Systems.
   6. Underwriters Laboratories, Inc. (UL):
      a. 508 - Standard for Industrial Control Equipment.
      b. 2200 - Standard for Stationary Engine Generator Assemblies.

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Equipment supplier: Manufacturer of at least one of the following items:
      a. Engine.
      b. Alternator (generator).
      c. Control system.
   2. Standby rated duty: Continuous operation for the duration of any power outage.

## 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Weight of engine generator skid.
   2. Dimensions of engine generator skid, including length, width, and height.
   3. Type and grade of fuel recommended.
   4. Fuel and lubricating oil consumption at:
      a. 50-percent load.
      b. 75-percent load.
      c. 100-percent load.
   5. Type and grade lubricating oil recommended.
   6. Amount of lubricating oil required per oil change.
   7. Normal lubricating oil consumption.
   8. Recommended lubricating oil change periods:
      a. By hours run.
      b. By time.
   9. Combustion air required.
   10. Cooling air required.
   11. Gauges to be furnished with engine and the normal operating range of each:
       a. Oil pressure.
       b. Coolant temperature.
       c. Fuel pressure.
   12. Time interval from start-up contact closure until full load capabilities are available.
   13. List of at least 4 installations using major components of the same type furnished for this application:
       a. Include name and telephone number of the persons most familiar with this equipment who can be contacted during the Submittal review.
   14. Number of cylinders, bore, stroke, and piston speed.
   15. Displacement in cubic inches.
   16. Compression ratio.
   17. RPM at 60 hertz.
   18. Size of exhaust outlet.
   19. The following gaseous exhaust emissions in grams/BHP-HR and Lbs/BHP-HR:
       a. NOx.
       b. HC.
       c. CO.
       d. PM.
       e. Other exhaust emissions as required by the local air quality management district issuing the permit for the engine generator system.
       f. These levels shall be reported at rated speed and load as measured by SAE J177 and J215 recommended practices.
   20. Voltage and frequency variation and duration with the step application and removal of 25 percent, 50 percent, 75 percent, and 100 percent of resistive load maximum.
   21. Time-overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided by the output circuit breaker.

22. Battery discharge ampere ratings at the 8-hour rate and the 1-minute rate to 1.75 volts per cell.
23. Certified published engine horsepower curves showing the manufacturer's engine rating for generator set standby and prime power application.
24. Free field mechanical noise level at 23 feet. Provide overall decibels (A) rating.
25. Exhaust noise level at 5 feet from discharge end of silencer.
26. Start battery catalog number and descriptive bulletin.
27. Recommended spare parts.
28. Space and ambient temperature requirements for the engine control panel.
29. Manufacturer of:
    a. Engine.
    b. Generator.
    c. Generator control panel.
    d. Radiator.
    e. Enclosure.
30. Estimated number of days to ship complete unit.
31. Jacket water heater.
32. Strip heaters.
33. Crank case heaters.

C. Shop Drawings:
1. Provide detailed dimensional and to-scale layout drawings, including:
    a. A single drawing incorporating all equipment furnished:
        1) Submittals that consist solely of individual drawings for each component and require that these sheets be compiled by the Engineer in order to view the entire piece of equipment are not acceptable.
2. Detailed electrical wiring diagrams of the engine and generator, including:
    a. Engine interconnection terminal box.
    b. Generator interconnection terminal box.
    c. Fuel system drawings.
    d. Interface drawings between the engine driven generator skid and the transfer equipment.
    e. Wiring diagrams to show wire numbers and terminal block identifications:
        1) Wire numbers are to correspond to the wire number on the equipment.
        2) Wires are to be numbered.
    f. Complete interior and exterior control panel layout:
        1) Scaled.
        2) With device descriptions.
        3) With nameplates.

D. Calculations:
1. Complete loading calculations to support the recommended size of the engine-generator based upon actual facility loads.
2. Documentation identifying the maximum static pressure acceptable for the radiator fan. It is the manufacturer's responsibility to then provide calculations as part of the layout drawings, to ensure that the transition ductwork at the discharge of the radiator does not exceed the maximum static pressure acceptable for the radiator fan.
3. Certification that a torsional analysis has been completed.
4. Exhaust system silencer noise attenuation curves.
5. Factory certification of the radiator ambient capability.

6. Exhaust system pressure loss calculations: Include piping, fittings, silencer, and rain cap in loss calculations.

E. Delegated Design Submittals:
   1. Project-specific calculations with anchoring and bracing details based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. Vibration isolator selection calculations.
      b. Vibration isolator anchoring calculations.
      c. Exhaust silencer structural support calculations where the silencer is not mounted to the generator or generator enclosure.

F. Installation instructions:
   1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
   2. Provide manufacturer’s installation instructions.

G. Quality Control Submittals:
   1. Manufacturer’s representative qualifications.
   2. Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.
   3. Manufacturer’s Certificate of Installation Verification as specified in Section 01756 - Commissioning.
   4. Test reports.
      a. Prototype test results.

H. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

I. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Operating instructions:
      a. Printed and framed instruction chart shall be permanently mounted in the generator enclosure. Chart must detail the operational functions of normally used controls that have been placed on the front of the control equipment.
   3. Maintenance manual:
      a. Printed and bound instructions covering details pertaining to care and maintenance of equipment, as well as data identifying all parts.
      b. These manuals must include, but are not limited to, the following:
         1) Electrical controls:
            a) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
            b) Detailed control instructions, which outline the purpose and operation of every control device used in normal operation.
            c) Description of the sequence of operation that outlines the steps, which the controls follow during normal power failure and normal power return conditions.

d) Schematic, wiring, and external diagrams. Also, internal device wiring and schematic diagrams for sub-assemblies used in the equipment:
(1) Drawing to be furnished in a reduced 11-inch by 17-inch format and shall be fully legible at that drawing size.

2) Engine and generator:
a) Standard operational manuals normally furnished by the manufacturer.
b) Repair parts manuals normally furnished by the manufacturer:
(1) Detailing parts and sub-assemblies, which are available as repair parts.

3) Shop maintenance manuals:
a) Provide 1 shop manual on site that is equivalent to the manual used by factory-authorized shop repair personnel.
b) Manuals for the following equipment:
(1) Engine.
(2) Radiator.
(3) Generator.
(4) Engine generator control panel.

c. Furnish a minimum of 6 manuals of each type identified, except for the shop maintenance manual. Provide 1 additional copy on compact disc (CD) as specified in Section 01782 - Operation and Maintenance Manuals.

## 1.06 QUALITY ASSURANCE

A. Coordinate the generator control design with the switchgear or transfer switches specified in the electrical Specifications and as indicated on the Drawings.

B. Manufacturer qualifications:
1. Manufacturer of the engine, generator, and major items of auxiliary equipment must be in current production of such equipment.
2. Factory authorized parts and service facility located within 100 miles of the Project Site.

C. Regulatory requirements:
1. Meet NFPA 110 Type 10 (ten second) transfer requirements.
2. Regulations of the Fire Prevention Bureau of the Fire Department Having Jurisdiction.
3. International Fire Code.
4. Other applicable state and local codes.
5. EPA approved.
6. Requirements of local Air Quality Management District or Air Pollution Control District.

D. Generator set shall be manufactured to the applicable specifications on file with Underwriters Laboratories and labeled with the UL 2200 mark.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the engine-driven generator skid and associated equipment to the jobsite on equipment that will allow the Contractor to use the equipment he has on site to efficiently unload the engine-driven generator skid.
   1. Must be equipped with removable lifting and jacking angles, eye bolts, etc., to facilitate unloading and move-in operations.

B. Engine-driven generator skid is to be shipped from the factory complete with lifting eyes, jacking angles, etc., attached to the structural base.

C. Provide the services of a manufacturer's authorized representative to:
   1. Be present at the jobsite when the engine-driven generator arrives:
      a. Act as an advisor in assisting the Contractor regarding the unloading and move-in operations.
   2. Coordinate the delivery of the shipment with the Contractor.
   3. Before start-up, furnish written certification that the entire installation and connections, both mechanical and electrical, have been inspected and are proper and consistent with Drawings and Specifications.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Complete factory prototype and factory acceptance tests in accordance with NFPA 110 and submit results for the Engineer's review.
   2. Conduct factory acceptance test and submit certified test results for the Engineer's review.
   3. Ship equipment to Project Site after successful completion of factory acceptance test.
   4. Assemble equipment in the field.
   5. Conduct field acceptance test and submit results for the Engineer's review.
   6. Submit manufacturer's certification that equipment has been properly installed and is fully functional for the Engineer's review.
   7. Conduct Owner Training sessions.
   8. Commissioning and start-up as specified in Section 01756 - Commissioning.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Extended warranty:
   1. Generator set and associated equipment shall be warranted for a period of not less than 2 years from the date of commissioning against defects in materials and workmanship.

## 1.11 SYSTEM START-UP

A. Provide manufacturer services, including, but not limited to:
   1. Furnish the services of manufacturer-certified technicians during the start-up and adjustment period to ensure that items furnished are in proper operating condition:
      a. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
      b. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
      c. Provide training in accordance with the Owner Training article of this Section.
      d. Engine technician and electrical technician may be the same individual if certified by the respective equipment manufacturers in both engine and electrical fields.
   2. Furnish a written report after the start-up:
      a. Report must state that the installation is complete and satisfactory:
         1) List the items requiring additional attention.
   3. Minimum required time on site by technician for start-up:
      a. One day to inspect entire installation, start-up, test operation, and conduct acceptance tests.

## 1.12 MAINTENANCE

A. Furnish the following spare parts:
   1. Sufficient coolant so that entire system may be flushed and replaced after initial burn-in period.
   2. Sufficient lubrication products so that the entire system may be flushed and replaced after initial burn-in period.
   3. Three sets of lube oil filters, fuel filters, and gaskets.
   4. Two sets of air filters.
   5. Two sets of belts.
   6. Twelve spare lamps of each different lamp type.
   7. Two fuses (for each control circuit).
   8. Provide a 2-pronged battery test voltmeter.
   9. One set of crankcase breather filters.

B. Special tools: Furnish a set of specialty tools necessary for routine maintenance of the equipment.

C. Maintenance service: Provide manufacturer’s standard service and maintenance contract for the Owner’s review and/or acceptance.

## PART 2 PRODUCTS

### 2.01 GENERAL (NOT USED)

### 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Provide a complete automatic standby spark-ignited combination natural gas/LP vapor fueled engine driven generator system with necessary components to make a complete and operating engine-driven power supply.

C. Include the supply of such minor details of electrical, plumbing, or mechanical work not specified or indicated on the Drawings, which are necessary for the successful operation of the combination natural gas/LP vapor fueled engine-driven generator required by these Specifications.

D. Description of operation:
   1. As specified in Section16491 - Transfer Switches.

E. Step sequence:
   1. Step 1: Non-controllable loads:
      a. PNL-AVV-P, 30kW.
      b. PNL-ROS-P, 25 kVA.
      c. XFMR-PNL-CPS, 45 kVA.
   2. Step 2:
      a. CWP-5161, 100 Hp (RVSS).
   3. Step 3:
      a. CWP-5162, 100 Hp (RVSS).

### 2.03 MANUFACTURERS

A. Engine generators:
   1. One of the following or equal:
      a. Caterpillar.
      b. Onan-Cummins.

B. Governor:
   1. One of the following or equal:
      a. Isochronous electronic by engine manufacturer.
      b. Woodward, digital type, Model 723, with EGP type actuator sized for the engine.

C. Battery:
   1. The following or equal:
      a. Hawker.

D. Exhaust system:
   1. One of the following or equal:
      a. Silencer:
         1) Harco Manufacturing.
         2) Silex Innovations.
      b. Expansion joint:
         1) DME.
      c. Exhaust pipe insulation:
         1) As specified in Section 15082 - Piping Insulation.
      d. Expansion joint insulation:
         1) Pittsburgh-Corning, Temp-Mat.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Generator system performance requirements:
   1. Power output rating: Minimum kilowatts and voltage as indicated on the Drawings, delivered at 0.8 power factor, 3-phase, 4-wire, 60 hertz, without exceeding NEMA MG-1 temperature rise limits.
   2. It is the manufacturer's responsibility to properly size the engine generator based upon Site conditions and actual loads. Drawings and Specifications indicate a minimum size that the Engineer has determined based upon non-certified information.
      a. Size the engine generator for a maximum voltage drop at any load step of no more than 10 percent.
      b. No increase in Contract amount will be considered if the equipment size needs to be increased to meet the load requirements after bids have been submitted.
      c. Increases in size as a result of manufacturer sizing shall include any and all conduit and wire size changes.

B. Characteristics of assembled unit:
   1. Engine-driven generator consists of a spark-ignited, combination natural gas/LP vapor -fueled engine directly coupled to an electric generator providing continuous electric power for the duration of any power failure of the normal utility power supply.
   2. Engine must start, attain full speed, voltage, and assume full load within a maximum of 10 seconds, with jacket water at 85 degrees Fahrenheit.
   3. Furnish the engine-driven generator on a steel sub-base to support engine, generator, and accessories as a unit:
      a. Base: Welded construction.
      b. Engine direct connected through a flexible coupling to a single bearing generator.
      c. System free of injurious torsional and bending vibrations within a speed range from 10 percent below to 10 percent above synchronous speed.
      d. Balanced such that the peak-to-peak amplitude of vibration velocity in any direction does not exceed the engine or generator manufacturer's published limits.

e. If shims are required under the feet of the generator for alignment purposes, use 1-piece laminated shim stock that covers at least 90 percent of the foot.
f. Provide a complete assembled engine-driven generator skid requiring only the following field mechanical connections:
    1) Power leads from generator to the automatic transfer equipment.
    2) Control connections to:
        a) Plant control system.
        b) Generator control system.
        c) Automatic transfer equipment.
    3) Exhaust system.
    4) Fuel lines.
g. Connections to engine-driven generator skid:
    1) Flexible connections are required on connections to the engine generator and are to be supplied by the manufacturer.
    2) These connections include, but are not limited to:
        a) Exhaust.
    3) Length of flexible connections to exceed the flexible connector manufacturer's minimum length recommendations for the diameter used and for the misalignment as measured after installation.

## 2.07 COMPONENTS

A. Engine generator base:
1. Support system:
    a. Bolt the engine-driven generator to steel pads that are an integral part of structural support base.
    b. Vibration isolators shall be provided between the engine generator and welded steel base or between the base and the floor:
        1) As recommended by the manufacturer.
    c. Support system design must meet the seismic requirements of the Project Site.
    d. Vibration isolators to properly support the engine driven generator skid on its concrete base:
        1) Isolators located for equal load distribution and deflection per isolator.
        2) Spring type designed for the load and seismic conditions as identified for the Site.

B. Engine:
1. Spark-ignited, 4-cycle low emission unit, turbocharged, and aftercooled.
2. Rated net horsepower of the engine with accessories, including radiator fan, must not be less than that required to produce the minimum specified generator capacity at Site altitude.
3. For dual fuel systems, changeover from primary to secondary fuel shall be automatic.
4. Equipped and designed as follows:
    a. Dual spin-on type replaceable lube oil filter cartridges.
    b. Replaceable fuel filters.
    c. Heat treated forged steel crankshaft:
        1) Dynamically balanced.
    d. Forged steel connecting rods.

e. Crankshaft driven gear type lubricating pump.
f. Fuel system:
    1) Natural gas pressure regulator.
        a) Install before gas inlet connection.
        b) Set pressure to 15” W.C.
    2) Electric fuel shut-off valve.
g. Engine air cleaner: Dry type replaceable filter.
h. 12- or 24-volt direct current positive engagement solenoid shift-starting motor:
    1) Starting equipment must include the necessary devices to prevent an overcrank and lockout if the starter pinion fails to engage the flywheel ring gear on the initial crank attempt.
    2) This starter disconnect is to electronically sense the speed of the flywheel and when the flywheel setpoint speed has been reached, the electronic control signals the starter disconnect to disengage.
i. Oil level dip stick and oil drainpipe with valve and pipe plug:
    1) Oil drainpipe and valve are to extend 3 inches beyond edge of engine base.
j. Dry electrical contacts to report:
    1) Low oil pressure.
    2) Over speed.
    3) High water temperature.
k. Engines requiring glow plugs are not acceptable.
l. Crankcase breather filter:
    1) Provide crankcase ventilation system with coalescing filter/trap for blowby:
        a) Coalescing filter to be replaceable.
    2) If the engine manufacturer recommends an open crankcase breather system, route outlet of breather filter to outside at 3 inches above grade and away from engine components:
        a) Provide on breather outlet Nelson “EcoVent” or equal, sized to match engine breather flow.
    3) If the engine manufacturer recommends a closed crankcase breather system, provide integral crankcase pressure regulator with an automatic internal filter bypass and bypass indicator:
        a) Unit to be Racor Model CCV 4500 or equal.
m. Governor:
    1) Isochronous type to maintain engine speed:
        a) Within 0.5 percent for steady state conditions.
        b) Within 5 percent for a no load to full load step with recovery to within 2 seconds of step load application.
        c) Suitable for use on combination natural gas/LP vapor-fueled engines.
        d) Electronic governor control of fuel.
        e) Suitable for automatic, unattended starts.
        f) Speed sensing failure circuit to signal actuator to close if speed pick-up signal is lost.
        g) With speed pick-up sensor.
        h) With capabilities of local or remote speed settings.
        i) Adjustable acceleration rate control from 0 to 8 seconds.
        j) Personnel guards over exposed moving parts.

n. Equipped with a continuous duty shutdown system for normal remote stopping.
o. Equipped with gauges to indicate:
   1) Lube oil pressure.
   2) Fuel pressure.
   3) Gauges are to be mounted such that vibration will not cause premature failure.
p. Monitor engine coolant temperature by a thermometer with thermometer well or a temperature gauge.

5. Regulatory requirements:
   a. Specifically designed to meet the discharge of gaseous pollutants to the atmosphere as required by the EPA and local agency issuing the permit for the engine generator system.

C. Exhaust system:
1. Provide a complete exhaust system following the general scheme as indicated on the Drawings and as specified.
2. Back pressure:
   a. Provide components such that the maximum backpressure in the exhaust system, including piping and silencer is as required by the engine manufacturer, measured at the exhaust manifold header:
      1) Reduce allowable back-pressure when recommended by the engine manufacturer.
   b. Provide each exhaust manifold header with a lugged, tapped connection for the attachment of a test manometer.
3. Exhaust piping:
   a. Type: Schedule 40 high temperature black steel pipe in accordance with ASTM A106.
   b. Drainage: Slope piping to a drain point and provide drain plug.
   c. Finishes: Sand blast and coat outside of exhaust piping with not less than 6 mils of inorganic zinc prime.
      1) Finish coat in the field as specified in Section 09910 - Painting.
   d. Insulation: As specified in Section 15082 - Piping Insulation for engine exhaust piping.
4. Exhaust expansion joints:
   a. Type:
      1) Metal with convoluted portion of 0.038-inch-thick Type 321 stainless steel.
      2) Non-convoluted portions of expansion joint to be Type 304 stainless steel, Schedule 10S pipe.
      3) Provide flanged ends with ASME B16.5, Class 150 bolt hole drilling.
   b. Length: Minimum of 18 inches in length.
   c. Movement:
      1) Rated for a minimum of 1-inch lateral movement, and 1/2-inch axial movement.
      2) Rated movement defined as plus or minus travel from neutral or free position.
   d. Design life: Infinite cycle life with 1,200 degrees Fahrenheit exhaust, no insulation over the expansion joint, and continuous duty service.

e. Insulation:
   1) Insulate expansion joints with custom fitted, removable with reusable fastening system, ceramic fiber insulation blankets enclosed between inner and outer high temperature fabric cover rated for 1,200 degrees Fahrenheit continuous duty.
5. Exhaust silencer:
   a. Type: Heavy-duty industrial type fabricated of welded steel with ported tubes and snubbing chambers, and a rating meeting the specified sound attenuation.
   b. Mounting: As indicated on the Drawings.
   c. End connections: Steel flanges with Class 150-pound drilling pattern.
   d. Shell:
      1) Sufficiently heavy and reinforced to eliminate excessive vibration, stress, or deflection, and to support operating loads with the silencer at elevated temperatures and insulated as specified.
      2) Loads include insulation weight and connecting piping.
   e. Drain: Provide threaded, plugged condensate drain.
   f. Sound attenuation: Attain the following minimum sound attenuation at the listed octave band center frequencies with the engine at full load:

| Frequency (Hz) | 63 | 125 | 250 | 500 | 1,000 | 2,000 | 4,000 | 8,000 |
|---|---|---|---|---|---|---|---|---|
| Attenuation (dB) | 39 | 42 | 42 | 40 | 38 | 38 | 38 | 38 |

   g. Supports: Provide shell lug supports suitable for supporting and mounting the silencer as indicated on the Drawings; support design to account for elevated temperatures under insulated shell.
   h. Insulation: As specified for engine exhaust piping in Section 15082 - Piping Insulation.
   i. Pressure drop not to exceed 7-inch water column at maximum engine rating.

D. Weatherproof acoustical housing:
1. Provide engine enclosure to protect engine, generator, starting system, batteries, and other specified accessories from weather exposure.
2. Meet wind requirements at the Project Site.
3. Meet seismic requirements at the Project Site.
4. Construction:
   a. Not less than 14-gauge steel panel thickness.
   b. Panels and members hot dip galvanized after fabrication.
   c. Enclosure removable to allow for maintenance.
   d. Fitted with lockable latches.
   e. Stainless steel latches and hinges.
5. Finishing: Factory or shop finished in epoxy and urethane coating system as specified in Section 09910 - Painting.
6. Noise reduction:
   a. Provide acoustical insulation and acoustical enclosure ventilation louvers and fan discharge silencers as necessary to achieve a measured sound pressure level of 70 dBA when measured at 23 feet from the enclosure.
   b. Protect acoustical insulation with perforated metal covers and plastic bagging to prevent damage from abrasion or weather elements.

E. Engine jacket water heater:
   1. Provide an in-line thermostat that disconnects power when coolant temperature exceeds an adjustable setpoint.
   2. Contacts from the oil pressure switch to disconnect the heater power when the engine is running.
   3. Equip the water heater with shutoff valves and unions to allow heater replacement without draining the cooling system.
   4. Water heater connections with Aeroquip type hoses and fittings.
   5. Size heater such that the engine block temperature is maintained at 85 to 100 degrees Fahrenheit in a 40 degree Fahrenheit ambient temperature.
   6. Connect water heater and thermostat are to be connected to the engine in such a manner as to minimize heated water circulation through the radiator circuit.
   7. Water heater power is to be supplied from a normal (utility) power source:
      a. Heaters larger than 3,000 watts shall be 460 volts, 3-phase.

F. Alternator (generator):
   1. Brushless synchronous alternator.
   2. Re-connectable 12 lead, if available.
   3. Self-ventilated.
   4. Full amortisseur windings.
   5. Skewed for smooth voltage waveform.
   6. With permanent magnet generator pilot exciter.
   7. Drip-proof enclosure.
   8. Protected against corrosion.
   9. Single bearing design.
   10. Insulation:
       a. For continuous operation at 50 degrees Celsius ambient temperature.
       b. Class F (105 degrees Celsius rise by resistance) for medium voltage or Class H (125 degrees Celsius rise by resistance) for low voltage generators.
       c. Vacuum impregnated with epoxy varnish to be fungus resistant in accordance with MIL I-24092.
       d. Multiple dipped and baked with a non-hygroscopic varnish with a final dip of epoxy.
   11. Terminate alternator power leads using compression lugs on an insulator and bus bar system within the alternator junction box:
       a. These terminations must not require any taping to complete the connection.
       b. Utilize copper locomotive type cables to connect from the alternator to the load bank manual transfer equipment:
          1) Sized for 125 percent of the alternator full load current.
          2) Neutral conductors shall be sized at 100 percent of the alternator full load rating.
       c. Provide a ground terminal inside the junction box to terminate the ground cables between the alternator to the automatic transfer equipment ground bus:
          1) Minimum size of the equipment-grounding conductor: 12-1/2 percent of the size of the phase conductors.
   12. 120 VAC integral motor winding heaters wired to and powered from the engine control panel.
   13. Maximum balanced telephone interference factor not to exceed 50.

G. Alternator voltage regulator:
   1. Located in the engine control panel.
   2. Performance requirements:
      a. Maintain the steady state voltage within 0.5 percent:
         1) From 40 degrees Fahrenheit to 120 degrees Fahrenheit.
         2) From no load to full load conditions.
   3. Constant volts per hertz characteristics.
   4. Static type.
   5. Sized to match the power requirements at the permanent magnet generator pilot exciter.
   6. Include manual control to adjust voltage drop, voltage level, and voltage gain.
   7. With 3-phase sensing.
   8. Sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.
   9. Include loss of sensing shutdown to protect the generator against uncontrolled voltage output when the sensing circuit to the regulator is opened.
   10. Shut down regulator when the sensing circuit to the regulator does not have continuity.
   11. Include over-excitation shutdown to protect the generator against damage caused by prolonged field forcing.

H. Radiator and cooling system:
   1. Unit mounted:
      a. Furnish a skid mounted closed type radiator system for the engine driven generator:
         1) Sized and selected by the engine manufacturer.
      b. Provide necessary coolant specifically suitable for the location and conditions of service throughout the year:
         1) Ship both the engine and the radiator with the coolant installed.

I. Wiring:
   1. External wiring connection to and from the engine and alternator shall be made via 2 engine mounted junction boxes:
      a. Boxes shall be NEMA Type 12.
      b. One box shall be used for control and direct current power connections.
      c. Other box shall be used for the alternator output connections:
         1) Alternator output breaker may be used for these connections.
   2. Enclose wiring in an NEC approved and recognized conduit system selected and sized by the engine generator manufacturer:
      a. Suitable for the temperatures, vibrations, and conditions on the engine-driven generator skid.
   3. Control wiring shall terminate on terminal blocks in the control junction box:
      a. Connections shall be made to terminal blocks:
         1) 600-volt rated.
         2) Wires terminated on box with compression type ring type lugs, installed with proper tooling.
         3) Terminal blocks shall be numbered.
         4) Wiring in terminal box, both internal and field connections, shall be routed in plastic wire duct.
   4. Terminate wires using solderless compression type lugs:
      a. Lug manufacturer’s termination methods and tools must be used.

5. Splices are not allowed:
    a. Connections are to be made at the terminal blocks in the control junction boxes.

J. Battery system:
  1. Installed on the engine-driven generator skid.
  2. Provide extra flexible minimum 4/0 welding cable to make the connection between the battery and the engine:
      a. Proper compression lugs and tooling must be used to terminate these cables.
  3. Provide a 24-volt lead acid recombination no maintenance engine start battery system:
      a. Battery rated such that the 90-second cranking current to 1.0 volts per cell exceeds the starter rolling current at 40 degrees Fahrenheit:
          1) For the above ratings to be valid, the starter breakaway current must not exceed the rolling current by a factor of more than 2.5.
          2) Increase the battery size in order to supply power to the room ventilation louvers, automatic transfer equipment relaying and controls, and any direct current lighting.
  4. Charger:
      a. Sized to provide sufficient power to fully charge a drained battery and power the automatic transfer equipment relaying and controls.
      b. Located on the engine skid.
      c. With direct current ammeter and direct current voltmeter.
      d. With On-Off switch.
      e. Solid-state device with adjustable float voltage control.
      f. Constant voltage design with current limit.
      g. With an equalize switch which will allow the battery to be overcharged for maintenance purposes.
      h. Designed to meet the charge, float, and equalize requirement of the battery furnished.
      i. Overload and short circuit protection.

K. Generator control panel:
  1. Enclosure:
      a. Skid mounted.
      b. NEMA Type 12.
  2. Power supply to panel: 120/208-volt, 3-phase.
  3. Provide an integral flange-mounted disconnect to disconnect the 208 VAC power from all controls within the panel.
  4. Distribute power to devices required for the complete engine generator system.
  5. Provide, as a minimum, all needed transformers, relays, power supplies, overload, and short circuit protection needed in order to provide a complete and operating system:
      a. Engine generator controls.
      b. Interior light.
      c. Water heater.
      d. Battery charger.
      e. Motor winding heater.

L. Miscellaneous engine generator skid items:
   1. Provide the following items:
      a. Sectionalized drip pans.
      b. Rain shields for exhaust lines.
      c. Roof jacks.

M. Automatic generator control equipment:
   1. Provide a microprocessor-based control system for automatic starting, monitoring, and control functions for the engine generator system:
      a. UL 508 listed and labeled.
   2. Control system features and functions:
      a. Control switches:
         1) Mode selector switch: Initiates the following control modes:
            a) Provide a rotary switch or control panel keypads with status indicators.
            b) RUN or Manual position:
               (1) Generator set starts, and accelerates to rated speed and voltage.
            c) OFF or STOP position:
               (1) Generator set immediately stops, bypassing all time delays.
            d) AUTO position:
               (1) Generator set accepts a signal from a remote device to start and accelerate to rated speed and voltage.
         2) EMERGENCY STOP switch:
            a) Red “mushroom-head” pushbutton.
            b) Activating the emergency stop switch causes the engine to immediately stop, and be locked out from automatic restarting.
         3) RESET switch:
            a) Clears all faults and allow restarting the engine generator after it has shut down for any fault condition.
         4) PANEL LAMP switch or automatic display panel illumination.
      b. Alternating current output metering: Provide the control system with metering, including the following features and functions:
         1) Voltmeter:
            a) RMS voltage.
            b) Line-to-line.
            c) Line-to-neutral.
         2) Ammeter:
            a) RMS current.
         3) Frequency.
         4) Power factor.
         5) Kilowatts (kW):
            a) kW-hours.
            b) Output kW.
         6) Kilovars (kVars):
            a) kVar-hours.
            b) Output kVar.
         7) Provide digital metering:
            a) 1.0 percent accuracy.

c. Generator alarm and status display:
    1) Provide high-intensity LED alarm and status indication lamps. Functions indicated include:
        a) Red alarm-indicating lamps.
        b) Red common shutdown lamp.
        c) 2 green lamps:
            (1) One to indicate the engine generator is running at rated frequency and voltage based on actual sensed voltage and frequency on the output terminals of the generator set.
            (2) The second to indicate a remote start signal has been received.
        d) Flashing red lamp to indicate that the control is not in automatic state.
        e) Amber common warning indication lamp.
    2) Display the following alarm and shutdown conditions on an alphanumeric digital display panel:
        a) Low oil pressure (alarm).
        b) Low oil pressure (shutdown).
        c) Oil pressure sender failure (alarm or indication).
        d) Low coolant temperature (alarm).
        e) High coolant temperature (alarm).
        f) High coolant temperature (shutdown).
        g) High oil temperature (warning).
        h) Engine temperature sender failure (alarm or indication).
        i) Low coolant level (alarm or shutdown - selectable).
        j) Fail to crank (shutdown).
        k) Fail to start/overcrank (shutdown).
        l) Overspeed (shutdown).
        m) Low direct current voltage (alarm).
        n) High direct current voltage (alarm).
        o) High alternating current voltage (shutdown).
        p) Low alternating current voltage (shutdown).
        q) Under frequency (programmable for alarm or shutdown).
        r) Overcurrent (programmed for warning or shutdown).
        s) Short circuit - circuit breaker function (trip).
        t) Emergency stop (shutdown).
    3) Control shutdown fault conditions shall be configurable for fault bypass.

d. Engine status monitoring:
    1) Display the following status conditions on an alphanumeric digital display panel:
        a) Engine oil pressure (pounds per square inch or kilopascal).
        b) Engine coolant temperature (degrees Fahrenheit or Celsius).
        c) Engine oil temperature (degrees Fahrenheit or Celsius).
        d) Engine speed (revolutions per minute).
        e) Number of start attempts.
        f) Battery voltage (direct current volts).

e. Data logging and display provision:
    1) Log the last 10 warning or shutdown indications on the engine generator.

2) Monitor the total load on the generator:
   a) Maintain data logs of total operating hours at specific load levels ranging from 0 to 110 percent of rated load, in 10 percent increments.
   b) Display total hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load.
3) Control system to log:
   a) Total number of operating hours.
   b) Total kW hours.
   c) Total control on hours.
   d) Total values since reset.

f. Engine control functions:
   1) Provide a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles:
      a) Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
   2) Provide an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this Specification, including adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
   3) Provide time delay start (adjustable 0 to 300 seconds) and time delay stop (adjustable 0 to 600 seconds) functions.

g. Battery monitoring system:
   1) Initiate alarms when the direct current control and starting voltage is less than 25 VDC or more than 32 VDC.
   2) Disable the low voltage limit during engine cranking (starter engaged).
   3) Monitor direct current voltage as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

h. Remote control interfaces:
   1) Provide a minimum of 4 programmable output relays:
      a) Configurable for any alarm, shutdown, or status condition.
   2) Provide a minimum of 4 programmable inputs.

N. Generator output circuit breaker:
   1. Engine generator skid mounted and line side connected to alternator.
   2. Manually resettable.
   3. Line current sensing.
   4. Inverse time versus current response.
   5. Sized and coordinated to protect the generator from damage from overload and/or short circuit:
      a. Coordinated with down-stream devices:
         1) As specified in Section 16305 - Electrical System Studies.
   6. Breakers shall be furnished as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

## 2.08 ACCESSORIES (NOT USED)

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES (NOT USED)

## 2.11 SOURCE QUALITY CONTROL

A. Minimum design prototype tests:
   1. Perform tests in accordance with NFPA.
   2. Maximum power in kW.
   3. Maximum starting kilovolt-ampere at 35 percent instantaneous voltage dip.
   4. Alternator temperature rise:
      a. By embedded thermocouple.
      b. By resistance method.
      c. In accordance with NEMA MG1-22.40 and 16.40.
   5. Governor speed regulation under steady state and transient conditions.
   6. Fuel consumption at 25 percent, 50 percent, 75 percent, and 100 percent load.
   7. Harmonic analysis, voltage wave form deviation, and telephone influence factor.
   8. Cooling airflow.
   9. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
   10. Endurance testing.

B. Source Testing:
   1. Not witnessed.
   2. Test each engine generator under varying loads with machine safety guards and exhaust system in place. Complete engine generator system is to be tested at full load in the manufacturer's establishment:
      a. Owner's representative to observe the tests. Tests shall include:
         1) Radiator.
         2) Engine control panel.
         3) Single-step load pickup.
         4) Transient and steady-state governing.
         5) Safety shutdown device testing.
         6) Rated power.
         7) Maximum power.
      b. During the full load tests, re-circulate the radiator cooling air through the radiator as necessary to test the system under the maximum ambient conditions specified in this Section.
      c. Run the unit for 4 hours at 100-percent load with the following recordings made hourly:
         1) Frequency.
         2) Voltage.
         3) Amperage.
         4) Kilowatts.
         5) Room temperature as measured at the generator end of the unit.
         6) Radiator air inlet temperature.
         7) Coolant temperature.
         8) Oil pressure.
         9) Time engine takes to start in seconds.
      d. Record the following items:
         1) Maximum block load capabilities of the unit.
         2) Maximum fuel pump vacuum in inches of mercury as measured with the fuel suction line closed.
         3) Point at which over temperature shutdown occurs:
            a) By actual test of over temperature switch remote from engine.

4) Point at which over speed shutdown occurs:
   a) By actual test of speed switch remote from engine.
5) Point at which low oil pressure shutdown occurs:
   a) By actual test of low oil pressure switch remote from engine.
6) Point at which overcrank shutdown occurs.
7) Point at which overspeed shutdown occurs.
8) Low water temperature alarm.
9) Low fuel level alarm.
10) Fuel leak alarm.
11) Overvoltage alarm and shutdown.
12) Undervoltage alarm and shutdown.
13) Under frequency alarm and shutdown.
14) Low battery voltage alarm.

e. Test results must record any minor adjustments made during the test.
f. If major changes, as determined by the Engineer, are made, the 4-hour test must be repeated.

3. Furnish test reports and Manufacturer’s Certificate of Source Testing.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

### 3.03 INSTALLATION

A. General:
   1. Install the equipment as indicated on the Drawings.
   2. Perform Work in accordance with the manufacturer’s instructions and Shop Drawings.

B. By personnel experienced and regularly engaged in field installation of power generation systems:
   1. Make field mechanical and electrical connections.

C. Mount fuel tank at the elevation relative to the engine recommended by the manufacturer to achieve proper engine fuel flow.

D. Installation Verification:
   1. Furnish Manufacturer’s Certificate of Installation Verification.

### 3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.
   2. Perform field acceptance tests as specified in Section 16950 - Field Electrical Acceptance Tests.

C. Test actual backpressure during acceptance testing of the system.

D. Provide the services of a manufacturer’s representative for the following:
   1. Before start-up, inspect both mechanical and electrical installations, are complete and consistent with the Drawings and Specifications.
   2. Furnish the services of factory-certified technicians during the start-up and adjustment period to make sure items furnished are in proper operating condition:
      a. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
      b. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
   3. Perform installation check, start-up, and load test.
   4. Certify that fuel, lubricating oil, and antifreeze conform to the manufacturer’s recommendations under the environmental conditions present.
   5. Check accessories that normally function while the equipment is in standby mode for proper operation, before cranking the engine. These accessories include, but are not limited to:
      a. Jacket water heaters.
      b. Fuel heaters, when used.
      c. Battery charger.
      d. Generator strip heaters, when used.

E. Start-up under manual mode:
   1. Check for the following items:
      a. Exhaust leaks.
      b. External path for exhaust gases.
      c. Cooling airflow.
      d. Movement during starting and stopping.
      e. Vibration during running.
      f. Normal and emergency line-to-line voltage and phase rotation.

F. Automatic start-up:
   1. By means of simulated power outage, test the following:
      a. Set timers for proper system coordination.
      b. Remote automatic starting.
      c. Transfer of load.
      d. Automatic shutdown.
   2. Continuously monitor the following parameters during this test:
      a. Engine temperature.
      b. Oil pressure.
      c. Battery charge level.
      d. Generator voltage.
      e. Generator amperes.
      f. Frequency.

## 3.05 OWNER TRAINING

A. Perform Owner Training as specified in Section 01756 - Commissioning.
   1. Number of sessions:
      a. Operations: 2.
      b. Maintenance: 2.

## 3.06 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

END OF SECTION

SECTION 16262

VARIABLE FREQUENCY DRIVES 0.50 - 50 HORSEPOWER

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Variable frequency drives (VFD) 0.5 to 50 horsepower for control of NEMA Design B squirrel cage induction motors.

## 1.02 REFERENCES

A. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

B. National Electrical Manufacturers Association (NEMA).

C. Underwriters' Laboratories (UL):
   1. 508A - Standard for Safety for Industrial Control Panels.
   2. 845 - Standard for Motor Control Centers.
   3. 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems.

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Point of common coupling: The point of common coupling for all harmonic calculation and field measurements for both voltage and current distortions is defined as the closest directly connected bus supplying power to the VFD.

## 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.

c. Depth.
d. Weight.

4. Nameplate schedule.
5. Bill of material.
6. Ratings:
   a. Voltage.
   b. Phase.
   c. Input current.
   d. Output current.
   e. Interrupting rating.
   f. Momentary current rating.
7. List of recommended spare parts.
8. Catalog cutsheets for major components.
9. Design data:
   a. Efficiency and power factor values.
   b. Certification that the drive is sized for the full nameplate motor horsepower and current of the driven load at the installed altitude and ambient temperature.
   c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
   d. Certification that electronic circuits and printed circuit boards are conformally coated.
10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer’s statement of seismic qualification with substantiating test data.
    b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
1. Complete plan and elevation drawings showing:
   a. Dimensions.
   b. Panel, sub-panel, and component layout indexed to the bill of material.
   c. Conduit connections.
2. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.
3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
   a. Include terminal number and wire numbers.
4. Complete single-line and 3-line diagrams, including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
   a. Clearly indicate device electrical ratings on the Drawings.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

E. Installation instructions:
   1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Manufacturer's representative qualifications.
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer's representatives field notes and data.
      f. Owner Training.

G. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Spare parts list with supplier names and part numbers.
   3. Startup and commissioning instructions and data.
   4. Operating manuals:
      a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
   5. Operating instructions:
      a. Written descriptions detailing the operational functions of controls on the front panel.
   6. Maintenance manual:
      a. Furnish maintenance manuals with instructions covering details pertaining to care and maintenance of equipment as well as identifying all parts.
      b. Manuals shall include, but are not limited to, the following:
         1) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
         2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
         3) Schematic wiring and external diagrams:
            a) Furnish Drawings in a reduced 11-inch by 17-inch format that are fully legible at that size.

H. Test forms and reports:
   1. Submit complete factory acceptance test procedures and forms used during the test.

I. Manufacturer's Certificate of Installation and Functionality Compliance.

J. Manufacturer's field reports:
   1. Listing the setting of VFD adjustable parameters and their values after start-up.

K. Record Documents:
   1. Certified Record Documents of equipment with information listed above.

## 1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
   2. VFDs shall be UL 61800-5-1 listed and labeled:
      a. UL 61800-5-1 for individual units.
      b. UL 508A for VFD systems in control panels.
      c. UL 845 for VFD systems in motor control centers.
   3. VFDs shall be manufactured by the VFD manufacturer at its own facility which shall have a quality assurance program certified in accordance with ISO 9001.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the VFDs and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on-site off-loading equipment:
   1. VFDs shall be delivered to the site preassembled and wired.

B. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct factory acceptance test and submit certified test results for Engineer's review.
   2. Ship equipment to project site after successful completion of factory acceptance test.
   3. Assemble equipment in the field.
   4. Conduct field acceptance test and submit results for Engineer's review.
   5. Submit Manufacturers Certificate of Installation and Functionality Compliance.
   6. Conduct Owner's training sessions.
   7. Commissioning and process start-up as specified in Section 01756 - Commissioning.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

## 1.11 SYSTEM START-UP

A. VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

## 1.12 MAINTENANCE

A. Spare parts:
   1. The following shall be furnished:
      a. 1 complete VFD of each size furnished.
      b. Any special dedicated tools for emergency service and troubleshooting.
      c. Hardware and software required for configuration, maintenance, troubleshooting, and inquiry of drive parameters.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

D. Design requirements:
   1. Each VFD system consists of components required to meet the performance, protection, safety, testing, and certification criteria of this Section.
   2. VFD system:
      a. Is a fully integrated package.
      b. Includes material necessary to interconnect VFD system elements, even if shipped separately.
   3. Coordinate bearing protection methods with the supplier of the driven equipment.

E. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer:
   1. Each VFD shall be completely factory pre-wired, assembled, and then tested as a complete system by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.

2. VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics based upon the installed conditions:
   a. Provide equipment necessary to mitigate potential damage to motor insulation.
   b. Motors as specified in Section 16222 - Low Voltage Motors up to 500 hp.

F. Performance:
1. Operating envelope:
   a. Speed and torque requirements:
      1) Provide a variable torque or constant torque VFD as required by the driven load.
      2) VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 200 percent (25 to 120 hertz) speed range.
   b. Current requirements:
      1) Full rated current output on a continuous basis.
      2) Variable torque VFD:
         a) Minimum 110 percent current overload for 1 minute.
      3) Constant torque VFD:
         a) Minimum 150 percent current overload for 1 minute.
2. Minimum VFD system efficiency:
   a. 96 percent when operating at the rated kW output.
   b. VFD system efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$

      1) Power (Load) is the total power measured at the output terminals of the drive system, including VFD, output filters, or transformers.
      2) Power (Supply) is the total power measured at the input terminals of the VFD including input filters, line reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.
3. Total power factor:
   a. Minimum of 0.96 lagging across the entire speed range.
   b. At no speed shall the VFD have a leading power factor.
4. Frequency accuracy:
   a. Minimum of within 0.01 percent.
5. Speed regulation:
   a. Minimum of within 0.5 percent across the entire speed range.

## 2.03 MANUFACTURERS

A. One of the following, or equal:
1. ABB.
2. Allen-Bradley.
3. Danfoss VLT/Vacon.
4. Eaton.
5. Schneider Electric.
6. Siemens-Robicon.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. General:
   1. Sinusoidal pulse width modulated (PWM) type drive.
      a. 6-pulse insulated gate bipolar transistor (IGBT) power section.
      b. Microprocessor based controls.
      c. Line reactor and output device as specified in this Section.

B. Ratings:
   1. Voltage:
      a. Input voltage as indicated on the Drawings.

C. Operational features:
   1. Protective features:
      a. Provide the following minimum protective features:
         1) Motor overload protection.
         2) Instantaneous overcurrent.
         3) Instantaneous overvoltage.
         4) Undervoltage.
         5) Power unit overtemperature.
         6) Phase loss.
         7) VFD output short circuit.
   2. Control mode:
      a. Operation in either a constant volts/hertz or sensorless vector mode:
         1) Control mode selectable using the programming keypad.
   3. Frequency control:
      a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
      b. Programmable minimum frequency.
      c. Programmable maximum frequency.
   4. Acceleration/deceleration:
      a. Separately adjustable acceleration and deceleration rates:
         1) Each rate adjustable from 0.01 to 1,800 seconds.
   5. Spinning load:
      a. VFD shall be capable of determining the speed and direction of a spinning load, “catch” the load and accelerate or decelerate it without damage to the load.
   6. Programmable loss of signal:
      a. Upon loss of speed reference, the VFD shall be programmable to either:
         1) Stop.
         2) Maintain current speed.
         3) Default to pre-selected speed.
   7. Power interrupt ride-through:
      a. VFD shall be capable of continuous operation in the event of a power loss of 5 cycles or less.

8. Inputs/Outputs:
    a. Manufacturer’s standard number the following:
        1) Analog inputs:
            a) Configurable as either 0 to 10 V or 4 to 20 mA.
        2) Analog outputs:
            a) Programmable 4 to 20 mA isolated.
        3) Discrete inputs:
            a) Programmable.
        4) Discrete outputs:
            a) Programmable.
            b) Form C relay contacts.
        5) Potentiometer 3-wire input.
    b. Provide additional inputs/outputs as required to meet the control functions indicated on the Drawings.
9. Automatic control:
    a. PID capability utilizing an internal or external setpoint:
        1) Selectable setpoint source.
10. Diagnostics:
    a. Store a minimum of 4 fault conditions in non-volatile memory on a first in/first out basis.
    b. Operational parameters stored at the time of the fault:
        1) Operating frequency.
        2) Drive status.
        3) Power mode.
    c. Fault memory accessible via RS-232, RS-422, or RS-485.
11. Automatic restart:
    a. User selectable automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
        1) Programmable for up to 9 restart attempts.
        2) Adjustable time delay between restart attempts.

## 2.07 COMPONENTS

A. Enclosure:
1. NEMA Type 12 or motor control center as indicated on the Drawings.
2. Provide cooling devices required to maintain the VFD within the manufacturer’s specified temperature limits for the Project conditions:
    a. Provide cooling device failure alarm.

B. Power disconnect:
1. Flange-mounted thermal magnetic circuit breaker.
2. Lockable in the OFF position.

C. Input reactor:
1. Three percent input line reactor.

D. Output device:
1. Three percent output load reactor.
2. dV/dT filter:
    a. Common mode reduction: 30 percent minimum.

b. Motor terminal peak voltage limit: 150 percent of dc bus voltage with a motor lead length up to 1,000 feet.
c. Carrier frequency range: Up to 12 khz.
d. Efficiency: 98 percent minimum.
e. Class H insulation minimum.

E. Keypad:
1. Provide each VFD with a keypad for programming and control.
2. Keypad requirements:
a. Password security to protect drive parameters.
b. Mounted on the door of the VFD enclosure.
c. Back-lit LCD:
1) Minimum of 2 lines with a minimum of 16 characters per line.
d. Programming and display features language: English.
e. Capable of displaying the following parameters:
1) Speed (percent).
2) Output current (amperes).
3) Output frequency (hertz).
4) Input voltage.
5) Output voltage.
6) Total 3-phase kilowatt.
7) Kilowatt-hour meter.
8) Elapsed run time meter.
9) Revolutions per minute.
10) Direct current bus voltage.
3. In addition to keys required for programming, provide the following controls on the keypad:
a. Auto/manual selector.
b. Start pushbutton.
c. Stop pushbutton.
d. Jog pushbutton.
e. Speed increment.
f. Speed decrement.
g. Forward/reverse selector.
h. Run LED indicator.
i. Program LED indicator.
j. Fault LED indicator.
4. Provide the VFD with the hardwired controls as indicated on the Drawings.

F. Control power transformer:
1. Furnish a control power transformer mounted and wired inside the VFD enclosure.
2. With primary and secondary fusing.
3. Sized to power VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.

## 2.08 ACCESSORIES

A. Metal oxide varistors:
1. Provide protection for the VFD against:
a. Line transients: 5,000-volt peak minimum.

b. Line to ground transients: 7,000-volt peak minimum.

B. Conformal coating:
1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as a protection against moisture, dust, temperature extremes, and chemicals such as $H_2S$ and chlorine.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
2. Install anchors of type and material indicated on approved anchoring designs.
3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
1. Furnish cables, conduit, lugs, bolts, and other accessories needed to complete the installation of the VFD (free-standing or within motor control center).
2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
3. Perform work in accordance with manufacturer's instructions and Shop Drawings.
4. Furnish components and equipment as required to complete the installation.
5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
6. Install free-standing enclosures on a raised concrete housekeeping pad:
   a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
   b. Weld and/or bolt the VFD frame to the leveling channels.
7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
   a. Improperly cut holes will require that the entire panel be replaced:
      1) No hole closers or patches will be allowed.
8. Bundle circuits together and terminate in each unit:
   a. Tie with nylon wire ties.

b. Label wires at each end with wire numbers shown on the approved control drawings.
c. Connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing (Factory Acceptance Tests):
1. Not witnessed.
2. General:
a. Incoming inspection of components and raw materials based on strategic supplier base and experience.
b. VFDs furnished under this Section shall be tested and inspected as specified below. Testing of VFDs based on sampling plans is not allowed.
c. Testing procedures specified are the minimum acceptable requirements. Manufacturer may perform additional tests at its discretion.
3. Failure of any component during testing requires repair of the faulted component and complete retest.
4. Perform manufacturer's standard factory acceptance tests.
5. Furnish test reports and Manufacturer’s Certificate of Source Testing.

C. Installation Verification:
1. Furnish Manufacturer’s Certificate of Installation Verification.

D. Functional Testing:
1. As specified in Section 16950 - Field Electrical Acceptance Tests.

E. Owner Training:
1. Not required.

## 3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Provide the services of a VFD manufacturer representative for startup assistance and training:
1. Inspection and field adjustment:
a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
2. Startup field testing:
a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

## 3.06 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make drive parameters and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings, including, but not limited to:
      a. Minimum speed.
      b. Maximum speed.
      c. Skip speeds.
      d. Current limit.
      e. Acceleration time.
      f. Deceleration time.

END OF SECTION

SECTION 16265

REDUCED HARMONIC VARIABLE FREQUENCY DRIVES

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Reduced harmonic 18 pulse or active front end, variable frequency drives (VFD), 60 to 500 hp for control of standard NEMA Design B squirrel cage induction motors.

## 1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

B. Underwriters' Laboratories, Inc. (UL):
   1. 508A - Standard for Safety for Industrial Control Panels.
   2. 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems.

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. AFE: Active Front End.
   2. IGBT: Insulated Gate Bipolar Transistor.
   3. VFD: Variable Frequency Drive.

## 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Weight.

5. Nameplate schedule.
6. Bill of material.
7. Ratings:
   a. Voltage.
   b. Phase.
   c. Input current.
   d. Output current.
   e. Interrupting rating.
   f. Momentary current rating.
8. Catalog cutsheets for major components.
9. Surge protection data.
10. Design data:
    a. Efficiency and power factor values.
    b. Certification that the drive is sized for the full nameplate motor hp and current (at rated RPM) of the driven load at the installed altitude.
    c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
    d. Certification that electronic circuits and printed circuit boards are conformably coated.
    e. Certification that the VFD will operate with all power sources (including alternate utilities and on-site generation when applicable).
11. List of recommended spare parts.
12. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer’s statement of seismic qualification with substantiating test data.
    b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
1. Complete plan and elevation drawings showing:
   a. All dimensions.
   b. Panel, sub-panel and component layout indexed to the bill of material.
   c. Conduit connections.
   d. Required clearance around equipment.
2. Block diagram showing the basic control and protection systems identifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.
3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
   a. Wiring diagrams shall include terminal number and wire numbers.
4. Complete 1-line and 3-line diagrams, including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
   a. Device electrical ratings shall be clearly indicated on the Drawings.

D. Delegated Design Submittals:
  1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
    a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
    b. For equipment installed outdoors.

E. Installation instructions:
  1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
  2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
  1. As specified in Section 01756 - Commissioning, including the following:
    a. Manufacturer's representative qualifications.
    b. Certificates:
      1) Requirements as specified in this Section.
    c. Test Plans:
      1) Test requirements as specified in this Section.
    d. Test Reports.
    e. Manufacturer's representatives field notes and data.
    f. Owner Training.

G. Certifications:
  1. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with new and existing sources (utility sources and on-site generation in possible operating configurations).
  2. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with new and existing VFDs in the existing and new distribution system.

H. Installation instructions:
  1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
  2. Provide manufacturer's installation instructions.

I. Calculations:
  1. Harmonic study:
    a. Perform a preliminary harmonic analysis:
      1) Measure conductor lengths and obtain other information required for the analysis from Drawings.
      2) A power system short circuit ratio of 20 shall be used.
      3) VFDs shall be assumed to be operating at maximum speed and maximum load.
      4) Short circuit current (ISC) utilized for the harmonic analysis calculations is defined as:
        a) ISC = 20 * (Sum Total Full Load Amps of all VFDs).

b. A separate harmonic analysis shall be performed based on the standby generator system:
    1) Coordinate with the generator manufacturer and the VFD manufacturer so the actual characteristics for the generator supplied, for this Project are used in the harmonic analysis.
    2) Verify the characteristics of the existing generator and coordinate with the VFD manufacturer.

2. Detailed calculations or details of the actual physical testing performed on the VFD to prove the VFD is suitable for the seismic conditions at the Project Site.

J. Test forms and reports:
1. Submit complete factory acceptance test procedures and forms used during the test.
    a. For VFD units less than 250 hp, provide certified test results for the actual VFD being furnished or prototype units. For VFD units 250 hp and larger, provide certified test results for the actual VFD being furnished.
    b. Provide the following certified test reports:
        1) Efficiency at rated power output and output frequency of 60 hertz.
        2) Power factor at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent speed.
        3) Harmonics at the input terminals of the VFD at 100 percent speed and 100 percent load:
            a) Voltage distortion: Measure individual harmonics up to and including the 50th harmonic and total harmonic distortion.
            b) Current distortion: Measure individual harmonics up to and including the 50th harmonic and total demand distortion.
2. Submit complete field acceptance test procedures and forms used during the test:
    a. Testing performed by independent organization as specified in Section 16950 - Field Electrical Acceptance Tests.

K. Record documents:
1. Certified record documents of equipment with information listed above.

L. Manufacturer's field reports:
1. Certification letter from the VFD manufacturer that the VFD(s) has been inspected and installed in accordance with the manufacturer's requirements.
2. Report listing the setting of VFD adjustable parameters and their values after start-up.
3. Certification letter from the VFD manufacturer stating that the VFD(s) are programmed to avoid system resonances when connected to the standby generator and will not conflict with generator system voltage regulator.

M. Operation and maintenance manuals:
1. Spare parts list with supplier names and part numbers.
2. Start-up and commissioning instructions and data.
3. Complete bill of material indexed to the Drawings, identifying the catalog or part numbers, manufacturer, and quantities of components of the VFD system.

4. Operating manuals:
   a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
5. Operating instructions:
   a. Written descriptions shall detail the operational functions of controls on the front panel including keypad functions and parameters.
6. Maintenance manual:
   a. Furnish maintenance manuals with instructions covering details pertaining to care and maintenance of equipment, as well as identifying all parts.
   b. Manuals shall include, but are not limited to, the following:
      1) Adjustment and test instructions covering the steps involved in the initial test, adjustment and start-up procedures.
      2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
      3) Schematic wiring and external diagrams:
         a) Furnish Drawings in a fully legible reduced 11-inch by 17-inch format.

## 1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
   2. VFDs shall be UL 61800-5-1 listed and labeled.
   3. VFD systems (packaged VFD panels) shall be UL 508A listed and labeled.
   4. VFDs shall be manufactured by the VFD manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship VFDs to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on site off-loading equipment:
   1. VFDs shall be delivered to the site pre-assembled and wired.
   2. Ship each VFD with 2 tamperproof accelerometers that record the maximum shock and vibration experienced by the VFD during shipping and handling.

B. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct factory acceptance test and submit certified test results for Engineer’s review.

2. Ship equipment to Project Site after successful completion of factory acceptance test.
3. Assemble equipment in the field.
4. Conduct field acceptance tests including harmonic testing and submit results for Engineer's review:
    a. Utility power sources and on-site generation shall be installed and operable for field test.
5. Submit manufacturer's certification that equipment has been properly installed and is fully functional for Engineer's review.
6. Conduct Owner's training sessions.
7. Commissioning and process start-up as specified in Section 01756 - Commissioning.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

## 1.11 SYSTEM START-UP

A. VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

## 1.12 MAINTENANCE

A. Maintenance service: Manufacturer shall describe the field service system available to support the proposed VFD system. As a minimum describe:
    1. Type of technical support available (e.g., system engineer and technician).
    2. Location of field service personnel.
    3. Field service daily rates in dollars per hour and dollars per day.
    4. Guaranteed response times to service requests.

B. Spare parts:
    1. The following spare parts shall be furnished:
        a. 1 spare fan for each VFD unit.
        b. 2 sets of ventilation filters for each VFD unit (if applicable in VFD cabinet louvers).
        c. Any special dedicated tools for emergency service and troubleshooting.
        d. Hardware and software required for configuration, maintenance, troubleshooting and inquiry of drive parameters.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria, and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. For equipment located in non-conditioned spaces, provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

D. Design requirements:
   1. Each VFD system shall consist of all components required to meet the performance, protection, safety, testing and certification criteria of this Section.
   2. VFD system:
      a. Is a fully integrated package.
      b. Includes material necessary to interconnect VFD system elements, even if shipped separately.
   3. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer.
   4. Each VFD shall be completely factory pre-wired, assembled and then tested as a complete package by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
   5. VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics:
      a. VFD manufacturer shall furnish equipment necessary to mitigate potential damage to motor insulation.
      b. Coordinate bearing protection methods with the supplier of the driven equipment.
      c. Motors as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.

E. Performance:
   1. Operating envelope:
      a. Speed and torque requirements:
         1) Provide a variable torque or constant torque VFD as required by the driven load.
         2) VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 110 percent (25 to 66 hertz) speed range.
      b. Current requirements:
         1) Provide 100 percent of rated output current on a continuous basis.
         2) Variable torque VFD:
            a) Minimum 110 percent current overload for 1 minute.
         3) Constant torque VFD:
            a) Minimum 150 percent current overload for 1 minute.

2. Harmonics:
   a. VFD shall meet the following distortion limits at 2 percent line voltage unbalance measured at the input terminals of the VFD:
      1) Voltage harmonics: Maximum allowable total harmonic distortion, THD, for each VFD shall not exceed 5 percent.
      2) Current harmonics: Maximum allowable total harmonic current distortion limit, TDD, for each VFD shall not exceed 5 percent as measured at the input terminals of the VFD system.
3. Efficiency:
   a. VFD system minimum efficiency shall be 93 percent at rated kilowatt output of the VFD. VFD system efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$

   b. Power:
      1) Load power is the total 3-phase power measured at the output terminals of the drive system, including the output filter.
      2) Supply power is the total power measured at the input terminals of the VFD including phase shifting transformer or active front end components and auxiliary equipment (e.g., controls, fans) for complete system operation.
4. Total power factor:
   a. Minimum of 0.96 lagging across the entire speed range.
   b. Under no operating conditions shall the VFD have a leading power factor.
5. Frequency accuracy:
   a. Minimum of within 0.01 percent.
6. Speed regulation:
   a. Minimum of within 0.5 percent across the entire speed range.
7. Capable of working with all available power sources (utility and on-site generation) and with all new and existing VFDs.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Allen-Bradley.
   3. Danfoss VLT/Vacon.
   4. Eaton.
   5. Schneider-Electric.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. General:
   1. Sinusoidal pulse width modulated, (PWM), voltage source type drive shall consist of the following:
      a. Rectifier section.
      b. Direct current link with capacitors.

c. Insulated gate bipolar transistor (IGBT), inverter section.
d. Microprocessor based controls.
e. Output filter.

2. Rectifier section:
   a. Provide VFDs with either an 18-pulse rectifier section or an active front end:
   b. 18-pulse rectifier:
      1) Integral phase shifting autotransformer:
         a) Converts 3-phase utility power to 3 sets of 3 power circuits with each set phase shifted and powering its own 3-phase bridge rectifier.
      2) Minimum 18-pulse diode rectifier section consisting of three 3-phase bridge rectifiers:
         a) Specifically designed as a system to share currents between the bridges to within 1 percent.
   c. Active front end rectifier:
      1) IGBT based converter module:
         a) 6 IGBTs minimum.
      2) Inductor/capacitor/inductor, LCL, harmonic filter:
         a) Low pass filter.
         b) Filter shall be disconnected from the line when the VFD is not running or powered off.
         c) Installed within same enclosure as VFD.
   d. 6-pulse rectifiers with harmonic filters are not allowed.

B. Ratings:
   1. Voltage:
      a. Input voltage: 480 Volts plus or minus 10 percent, 3-phase, 3-wire, 60 hertz.
      b. Solidly grounded.
   2. Short-circuit rating:
      a. 65 kA RMS symmetrical.

C. Operational features:
   1. Protective features:
      a. Annunciated at the keypad and available via network connection.
      b. Include the following protective features:
         1) Motor overload protection.
         2) Instantaneous overcurrent.
         3) Instantaneous overvoltage.
         4) Undervoltage.
         5) Power unit overtemperature.
         6) Phase loss.
         7) VFD output short circuit.
         8) VFD output ground fault.
         9) Blown fuse with blown fuse indication.
         10) IGBT protection.
         11) Cooling fan failure.
         12) Component failure.
   2. Control mode:
      a. VFD shall operate in either a constant volts/hertz or sensorless vector mode. Selectable using the programming keypad.

3. Frequency control:
    a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
    b. Programmable minimum frequency.
    c. Programmable maximum frequency.
4. Acceleration/Deceleration:
    a. Separately adjustable acceleration and deceleration rates.
    b. Each rate shall be adjustable from 0.01 to 1,800 seconds.
5. Spinning load:
    a. Capable of determining the speed and direction of a spinning load, “catch” the load and accelerate or decelerate it without damage to the load.
6. Programmable loss of signal:
    a. Upon loss of reference speed signal the VFD shall be programmable to either stop, maintain current speed, or default to preselected speed.
7. Power interrupt ride through:
    a. Capable of continuous operation in the event of a power loss of 5 cycles or less.
8. Hardwired inputs and outputs:
    a. Manufacturer’s standard number the following:
        1) Analog inputs:
            a) Configurable as either 0 to 10 volts or 4 to 20 mA.
        2) Analog outputs:
            a) Programmable 4 to 20 mA isolated.
        3) Discrete inputs:
            a) Programmable.
        4) Discrete outputs:
            a) Programmable.
            b) Form C relay contacts.
        5) Potentiometer 3-wire input.
    b. Provide additional inputs and outputs as required to meet the control functions indicated on the Drawings.
9. Real-time clock:
    a. Capable of providing time-stamped events.
    b. Set locally or via a remote controller.
    c. Programmable for day, month, year, local time zones in hours, minutes and seconds.
10. Diagnostics:
    a. Minimum of 4 fault conditions in memory on a first in - first out basis.
    b. Time stamped.
    c. Operating frequency, drive status and power mode shall also be stored at the time of the fault.
    d. Fault memory shall be maintained in the event of a power outage.
    e. Fault memory shall be accessible via RS-232, RS-422, RS-485, or USB.
11. Automatic restart:
    a. User selectable, automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
        1) Programmable for up to 9 automatic restart attempts with an adjustable time delay between restart attempts.

## 2.07 COMPONENTS

A. Enclosure:
   1. NEMA Type 12.
   2. Provide cooling devices required to maintain the VFD within the manufacturer’s specified temperature limits for the Project conditions:
      a. Provide cooling device alarm.

B. Power disconnect:
   1. Flange mounted thermal magnetic circuit breaker:
      a. Lockable in the OFF position.

C. Phase shifting transformer for 18-pulse VFDs:
   1. Auto-transformer.
   2. Integral part of the VFD assembly and factory mounted and wired within the VFD enclosure.
   3. Embedded thermal protection.
   4. Rated for rectifier duty.
   5. Copper or aluminum windings with 180-degree Celsius insulation.

D. Output filter:
   1. dv/dt filter:
      a. Common mode reduction: 30 percent minimum.
      b. Motor terminal peak voltage limit: 150 percent of dc bus voltage with a motor lead length up to 1,000 feet.
      c. Carrier frequency range: Up to 12 KHz.
      d. Efficiency: 98 percent minimum.
      e. Class H insulation minimum.

E. Keypad:
   1. Furnished with a keypad for programming and control.
   2. Password security to protect drive parameters.
   3. Mounted on the door of the VFD.
   4. Back-lit LCD with a minimum of 2 lines of a minimum of 16 characters each.
   5. Programming and display features language: English.
   6. Capable of displaying the following parameters:
      a. Speed (percent).
      b. Input current (amperes).
      c. Output current (amperes).
      d. Output frequency (hertz).
      e. Input voltage.
      f. Output voltage.
      g. Total 3-phase kilowatt.
      h. Kilowatt hour meter.
      i. Elapsed run time meter.
      j. Revolutions per minute.
      k. Direct current bus voltage.
   7. In addition to keys required for programming, keypad shall have the following:
      a. Automatic/Manual selector.
      b. Start pushbutton.
      c. Stop pushbutton.

d. Jog pushbutton.
e. Speed increment.
f. Speed decrement.
g. Forward/Reverse selector.
h. RUN indicator.
i. PROGRAM indicator.
j. FAULT indicator.
k. DRIVE READY indicator.
l. Diagnostics.

8. Provide the VFD with the hardwired controls indicated on the Drawings.

F. Control power transformer:
1. Mounted and wired inside the drive enclosure:
   a. Primary and secondary fusing.
2. Size transformer to supply power to all VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.

G. Line side tuning for AFE VFDs:
1. Provide 2 sets of line side tuning parameters: One for the normal utility supply, another for the alternate (generator) supply.
2. Parameters shall be selectable via the communications network or a digital input from a contact closure at the automatic transfer equipment or PCIS.
3. When more than 1 generator source is used, VFD shall be capable of storing multiple generator profiles to use as the alternate supply based on command inputs.

## 2.08 ACCESSORIES

A. Surge protection:
1. Metal oxide varistors:
   a. Provide protection for the VFD against:
      1) Line transients: 5,000-volt peak minimum.
      2) Line to ground transients: 7,000-volt peak minimum.

B. Conformal coating:
1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as $H_2S$ and chlorine.

C. Air filters:
1. Mounted on the outside of the VFD enclosure:
   a. Replaceable without requiring that the VFD be turned off or the door opened.
2. Located on the front or top of the VFD enclosure:
   a. Side or rear mounted air filters are not acceptable.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories needed to complete installation of the VFD (free-standing or within motor control center).
   2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
   3. Perform Work in accordance with the manufacturer's instructions and Shop Drawings.
   4. Furnish components and equipment as required to complete the installation.
   5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
   6. Install free-standing enclosures on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
      b. Weld and/or bolt the VFD frame to the leveling channels.
   7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.
   8. Bundle circuits together and terminate in each unit:
      a. Tie with nylon wire ties. As specified in Section 16123 - 600-Volt or Less Wires and Cables.
      b. Label wires at each end with wire numbers shown on the approved Control Drawings.
      c. Connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Not witnessed.
   2. VFDs furnished under this Section shall be tested and inspected as specified below.
   3. Testing procedures specified are the minimum acceptable requirements. Manufacturer may perform additional tests at its discretion.
   4. Failure of any component during testing requires replacement of the faulted component and a complete retest.
   5. Component tests:
      a. Preliminary inspection:
         1) Verify that components are correct.
         2) Verify that connections are properly torqued.
      b. Printed circuit boards:
         1) Test each printed circuit board in accordance with the manufacturer's standard testing procedure.
      c. Wiring:
         1) Control and power wiring continuity verified point-to-point.
         2) Hi-pot power and control wiring at manufacturer's recommended levels.
         3) Verify ground bond resistance.
      d. Load testing:
         1) No load testing in accordance with the manufacturer's standard factory test procedure.
         2) Full load testing:
            a) Test each VFD and all control logic with a representative motor or dynamometer load to simulate field operation conditions at 25 percent, 50 percent, and 100 percent full load current.
            b) Tests shall be conducted in a manner in which the inverter (IGBT) section supplies all the output power (kw) of the VFD system. Control strategies using a contactor or other means of bypassing the VFD when operating at the line frequency shall not be permitted.
            c) Tests shall be conducted using a minimum output frequency of 60 hertz, and a minimum switching frequency of 2.5 kHz.
   6. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Installation Verification:
   1. Furnish Manufacturer's Certificate of Installation Verification.

D. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

E. Owner Training:
   1. Perform Owner Training as specified in Section 01756 - Commissioning.
   2. Number of sessions:
      a. Operations: 1.
      b. Maintenance: 1.

## 3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Provide the services of a VFD manufacturer representative for start-up assistance and training:
   1. Inspection and field adjustment:
      a. Supervise the equipment installation and confirm controls have been properly installed, aligned, adjusted, and readied for operation.
      b. Configure AFE drives for new and existing sources (utility sources and on-site generation in possible operating configurations).
   2. Start-up field testing:
      a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
      b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.
      c. Compliance with the following specified parameters shall be verified by the VFD manufacturer:
         1) Motor terminal voltage:
            a) Make field measurements at the motor connection box.
            b) Make measurements of the full speed range of the VFD.
            c) Make measurements with a recording type oscilloscope.
         2) Harmonics:
            a) Make field measurements at the input terminals of the VFD with and without the VFD in operation.
            b) Harmonic testing shall include utility power as well as generator standby power.
            c) Make measurements with a recording type harmonic analyzer displaying individual and total harmonic currents and voltages:
               (1) Record currents and voltages for a minimum of 10 minutes.
               (2) Analyzers using snapshots are not acceptable.
      d. Utility sources and on-site generation shall be operational for start-up field testing.

## 3.06 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make drive parameter and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings, including, but not limited to:
      a. Minimum speed.
      b. Maximum speed.
      c. Skip speeds.
      d. Current limit.
      e. Acceleration time.
      f. Deceleration time.
      g. Carrier frequency.

END OF SECTION

## SECTION 16272

## DRY-TYPE TRANSFORMERS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Enclosed dry-type transformers:
      a. Rated 1 to 1,000 kilovolt-amperes, single and 3-phase.
      b. Primary voltage 600 volts and below.

### 1.02 REFERENCES

A. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE):
      a. 389 - IEEE Recommended Practice for Testing Electronics Transformers and Inductors.
      b. C57.96 - IEEE Guide for Loading Dry-Type Distribution and Power Transformers.
   2. Underwriters Laboratory (UL):
      a. 1561 - Standard for Dry-Type General Purpose and Power Transformers.
   3. United States Department of Energy (DOE):
      a. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

### 1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

### 1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Nameplate data.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Inrush current.
   5. Insulation system and temperature constraints.
   6. Number and rating of taps.
   7. Sound levels.

8. Connection diagrams:
    a. Primary.
    b. Secondary.
9. BIL rating.
10. Required clearances.
11. Percent impedance.
12. Efficiency.
13. Certification of full capacity capability at the Project elevation and ambient conditions.
14. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Delegated design submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
    a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
    b. For equipment installed outdoors.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. Provide manufacturer's installation instructions.

E. Commissioning submittals:
1. As specified in Section 01756 - Commissioning, including the following:
    a. Certificates:
        1) Requirements as specified in this Section.
    b. Test Plans:
        1) Test requirements as specified in this Section.
    c. Test Reports.

**1.05 QUALITY ASSURANCE (NOT USED)**

**1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)**

**1.07 PROJECT OR SITE CONDITIONS**

A. As specified in Section 01850 - Design Criteria.

**1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)**

**1.09 WARRANTY**

A. As specified in Section 01783 - Warranties and Bonds.

## PART 2 PRODUCTS

### 2.01 GENERAL (NOT USED)

### 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and connections as indicated on the Drawings:
   1. Transformers shall provide full capacity at the Project elevation and environmental conditions as specified in Section 01850 - Design Criteria after all derating factors have been applied.
   2. Suitable for continuous operation at full rating with normal life expectancy in accordance with IEEE C57.96.

### 2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Jefferson.
   4. Schneider Electric.

### 2.04 MATERIALS

A. Cores:
   1. Non-aging, grain-oriented silicon steel.
   2. Magnetic flux densities below the saturation point.

B. Windings:
   1. High-grade magnet wire.
   2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
      a. Cured to reduce hot-spots and seal out moisture.
   3. Material electrical grade:
      a. Copper.

### 2.05 MANUFACTURED UNITS (NOT USED)

### 2.06 EQUIPMENT

A. General:
   1. 10 kilovolts BIL for 600-volt class windings.
   2. Sound levels, in accordance with IEEE 389 test conditions, not to exceed:

| Kilovolt-Amperes Range | Audible Sound Level (dB) |
|---|---|
| 1-9 | 40 |
| 10-50 | 45 |

| Kilovolt-Amperes Range | Audible Sound Level (dB) |
|---|---|
| 51-150 | 50 |
| 151-300 | 55 |
| 301-500 | 60 |
| 501-700 | 62 |
| 701-1,000 | 64 |

3. Taps:
    a. 15 kilovolt-amperes and less:
        1) Two 5 percent full capacity primary taps below rated voltage.
    b. 25 kilovolt-amperes and larger:
        1) Four 2.5 percent full capacity primary taps below rated voltage.
        2) Two 2.5 percent full capacity primary taps above rated voltage.
    c. Operated by a tap changer handle or tap jumpers accessible through a panel.
4. Terminals:
    a. UL listed for either copper or aluminum conductors.
    b. Rated for 75 degrees Celsius.
5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with IEEE C57.96.

B. Transformers less than 15 kilovolt-amperes:
1. Insulation class: 185 degrees Celsius.
2. Temperature rise: 115 degrees Celsius.

C. Energy efficient transformers 15 kilovolt-amperes and larger:
1. Insulation class: 220 degrees Celsius.
2. Temperature rise: 80 degrees Celsius, except as noted below:
    a. 150-degree Celsius rise for dry-type transformers located in motor control centers.
3. Efficiency:
    a. In accordance with DOE 10 CFR Part 431.

D. Enclosures:
1. Heavy gauge steel:
    a. Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.
    b. Indoor: NEMA Type 2.
2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
3. Built-in vibration dampeners to isolate the core and coils from the enclosure:
    a. Neoprene vibration pads and sleeves.

## 2.07 COMPONENTS (NOT USED)

## 2.08 ACCESSORIES

A. Nameplates:
   1. Non-corrosive metal or UL listed non-metallic:
      a. Stamped, engraved or printed with the following information:
         1) Phases.
         2) Frequency.
         3) Kilovolt-ampere rating.
         4) Voltage ratings.
         5) Temperature rise.
         6) Impedance.
         7) Insulation class.
         8) BIL rating.
         9) Connection diagram.
         10) Weight.
         11) Manufacturer.
         12) The identification “transformer”.
         13) Classes of cooling.
         14) Tap voltage(s).
         15) Vector diagram.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES

A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer’s standard gray enamel rust-inhibiting paint.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Mounted as indicated on the Drawings.
   2. Install where not in direct contact with building structure.

3. Install on single layer vibration pad under the entire mounting surface:
    a. Manufacturers: The following or equal:
        1) Korfund.
4. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.
5. Ground the enclosure:
    a. To an equipment ground conductor in the conduit.
    b. To the facility grounding electrode system.
6. Floor mounted transformers:
    a. Install transformers on a housekeeping pad.
    b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer's recommendations.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Factory Tests:
    1. Applied voltage test to each winding and from each winding to the core:
        a. 600-volt class winding 4.5 kilovolt.
    2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.
    3. Voltage ratio and polarity.
    4. Sound level, performed in a test room with ambient sound level not exceeding 24 dB.
    5. Perform all tests in accordance with UL 1561.
    6. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Functional Testing:
    1. As specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL (NOT USED)

## 3.06 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

END OF SECTION

## SECTION 16273

## LIQUID FILLED PAD MOUNTED TRANSFORMERS

### PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Medium voltage, outdoor, liquid-filled pad mounted transformers.

### 1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. ASTM International (ASTM).

C. Institute of Electrical and Electronic Engineers (IEEE):
   1. C57.12.00 - IEEE Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.
   2. C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers.
   3. C57.12.26 - IEEE Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers.
   4. C57.12.28 - IEEE Standard for Pad-Mounted Equipment-Enclosure Integrity.
   5. C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power and Regulating Transformers.
   6. C57.91 - IEEE Guide for Loading Mineral-Oil-Immersed Power Transformers up to and including 100 MVA with 65 degrees or 55 degrees Average Winding Rise.
   7. C57.93 - IEEE Guide for Installation of Liquid-immersed Power Transformers.
   8. C57.98 - IEEE Guide for Transformer Impulse Tests.
   9. C57.106 - IEEE Guide for Acceptance and Maintenance of Insulating Mineral Oil in Electrical Equipment.
   10. C57.147 - IEEE Guide for Acceptance and Maintenance of Natural Ester Fluids in Transformers.

D. National Electrical Manufacturers Association (NEMA):
   1. TR-1 - Transformers, Regulators, and Reactors.

E. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

F. U.S. Department of Energy (DOE):
   1. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

## 1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

## 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Complete installation instructions.
   2. Complete storage and handling instructions.
   3. Kilovolt-ampere rating, including derating calculations.
   4. Primary/secondary connections.
   5. Primary voltage and available taps.
   6. Secondary voltage.
   7. BIL rating.
   8. Temperature rise.
   9. Lightning arrester data.
   10. %Z, %X, %R, X/R.
   11. Efficiency.
   12. Gross weight.
   13. Torque values for bolted connections for secondary cable connections.
   14. Manufacturer’s suggested hi-potential test procedures and test levels for field testing:
       a. Initial field test.
       b. Subsequent maintenance tests.
   15. Certification from the manufacturer stating the transformer design complies with IEEE C57.12.00.
   16. Type of oil.
   17. Gallons of oil.
   18. Weight of oil.
   19. Complete MSDS sheets. There is no C57 standard for ANSI or IEEE.
   20. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
       a. Manufacturer’s statement of seismic qualification with substantiating test data.
       b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
   1. Complete detailed, dimensioned drawings showing the equipment being furnished, with pertinent information, including the following:
       a. Dimensions and locations of conduit entrance windows.
   2. Complete nameplate schedule, except impedance.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.

E. Installation instructions:
   1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Manufacturer's representative qualifications:
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer's representatives field notes and data.

G. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Complete as-built dimensioned and scaled drawings for transformer.
   3. Recommended periodic maintenance requirements.
   4. Maintenance instructions including schedules, parts identification, troubleshooting, assembly instructions, parts list, and predicted life of parts subject to wear and deterioration.
   5. Recommended field test levels and procedures before installation and for maintenance purposes after being placed in service.
   6. Periodic maintenance torque values for bolts.
   7. List of recommended maintenance tests, test frequencies, test procedures, acceptable test result ranges and disposal recommendations for natural ester fluids in accordance with IEEE C57.147.
   8. Copies of factory test reports.

H. Record documents.

I. Calculations:
   1. Detailed calculations or details of the actual physical testing performed on the transformer to prove the transformer is suitable for the seismic requirements at the Project Site.

## 1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
   1. Manufacturer shall be in the business of regularly manufacturing the specified transformer for a minimum of 10 years with a satisfactory performance record.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship transformers to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment:
   1. Each transformer shall be shipped with a global positioning system (GPS) unit to record the shipping route.
   2. Provide monitoring of the acceleration the transformer experiences during shipment:
      a. GPS unit can record the acceleration.
      b. Utilize a G-force gauge that indicates that the acceleration has exceeded allowed values.
   3. Transformers that experience vertical accelerations greater than 3 G or horizontal accelerations greater than 5 G shall not be accepted.

B. Furnish temporary equipment heaters within the transformer to prevent condensation from forming.

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Make necessary field measurements to verify the equipment will fit in the allocated space in full compliance with the minimum clearances required by the NEC and local codes.
   2. Conduct factory acceptance test and submit certified test results for the Engineer’s review.
   3. Ship equipment to Project Site after successful completion of factory acceptance test.
   4. Assemble equipment in the field.
   5. Conduct field acceptance test and submit certified test results for the Engineer’s review.
   6. Verify installation is in accordance with IEEE C57.93.
   7. Submit manufacturer’s certification that equipment has been properly installed and is fully functional for the Engineer’s review.
   8. Set taps.
   9. Commissioning as specified in Section 01756 - Commissioning.

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Outdoor oil-filled, pad mounted transformers for operation on a 60 hertz system with voltage and kilovolt-ampere ratings as indicated on the Drawings.

### 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Pad mounted transformers shall be compartmental type, designed for outdoor installation on a concrete pad.

### 2.03 MANUFACTURERS

A. One of the following or equal:
   1. Asea Brown Boveri (ABB).
   2. Eaton/Cooper Power Systems.
   3. Schneider Electric.

### 2.04 MATERIALS

A. Windings:
   1. Primary and secondary windings shall be high conductivity copper.

B. Insulating fluid:
   1. Envirotemp FR3.Insulating fluid shall meet or exceed the requirements of the appropriate IEEE and ASTM fluid standards.

### 2.05 MANUFACTURED UNITS (NOT USED)

### 2.06 EQUIPMENT

A. Transformer and associated terminal compartments designed and constructed to be tamper-resistant:
   1. No externally removable screws, bolts, or other devices.

B. Ratings:
   1. 3-phase, 60 hertz.
   2. Self-cooled.
   3. 65-degree Celsius rise.
   4. Primary voltage as indicated on the Drawings.
   5. Primary connection as indicated on the Drawings.
   6. Secondary voltage as indicated on the Drawings.
   7. Secondary connection as indicated on the Drawings.
   8. Kilovolt-ampere rating as indicated on the Drawings.
   9. Basic impulse insulation level (BIL) in accordance with IEEE C57.98:
      a. 1.2 kV Class: 30 kV.

b. 2.5 kV Class: 45 kV.
c. 5.0 kV Class: 75 kV.
d. 8.7 kV Class: 75 kV.
e. 15 kV Class: 95 kV.

10. Sound levels:
    a. In accordance with NEMA TR1.
    b. Measurement procedure in accordance with IEEE 57.12.90.
11. Efficiency:
    a. Transformers 2,500 kVA and less shall have an efficiency rating in accordance with DOE 10 CFR Part 431.
12. Short-circuit capacity:
    a. Mechanical short-circuit capability in accordance with IEEE C57.12.90.
13. Thermal short-circuit capability in accordance with IEEE C57.12.00.

## 2.07 COMPONENTS

A. Core and coil:
   1. Manufactured from burr-free, grain-oriented silicon steel laminations and stacked to eliminate gaps in the corner joints.
   2. Insulated with B-stage, epoxy coated, diamond pattern, insulating paper, thermally cured under pressure to ensure proper bonding of conductor and paper.
   3. Clamped and braced to resist distortion caused by short-circuit stresses within ratings or by shipping and handling and to prevent the shifting of core laminations.
   4. Vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system:
      a. Energize the windings under vacuum to heat the coils and drive out moisture.
      b. While under a vacuum and the coils are heated, fill the tank with preheated, filtered and degassed insulating fluid.

B. Tank:
   1. Conforming to the enclosure integrity requirements in accordance with IEEE C57.12.28.
   2. Equipped with extra-heavy duty, welded-in-place lifting lugs and jacking pads:
      a. Provide adequate cross-bracing of the base to allow skidding or rolling in any direction.
   3. Capable of withstanding a pressure of 7 pounds per square inch gauge without permanent distortion, and 15 pounds per square inch gauge without rupturing.
   4. Provide a pressure relief valve as a means to relieve pressure in excess of pressure resulting from normal operation:
      a. Cracking pressure: 10 pounds per square inch gauge within 2 psig.
      b. Resealing pressure: 6 pounds per square inch gauge minimum.
      c. Zero leakage from reseal pressure to 8 pounds per square inch gauge.
      d. Flow at 15 pounds per square inch gauge: 35 scfm minimum.

C. Terminal compartments:
   1. Conforming to the enclosure integrity requirements in accordance with IEEE C57.12.28.
   2. Full-height, air filled primary and secondary terminal compartments with hinged doors shall be located side-by-side separated by a steel barrier, with the primary compartment on the left, complete with tamper resistant hardware.
   3. Hinges and pins to be passivated Type 304 stainless steel or equivalent corrosion-resistant metal.
   4. Doors and compartment hood shall be removable:
      a. Removable doorsill on compartments shall be provided to permit rolling or skidding of unit into place over conduit stubs in foundations.
   5. Doors in both the high-voltage section and the low-voltage section shall be able to be latched in the open position.
   6. Entire terminal compartment for the transformer shall be bolted to the transformer so that the terminal compartment may be unbolted from the transformer and the transformer removed without disturbing conduits that enter the compartment from the side or top.
   7. Minimum of 30-inches deep.
   8. Secondary compartment:
      a. Enclose the secondary termination bushings and provide for incoming cable from below the compartment.
      b. Compartment shall also house:
         1) Liquid level indicator.
         2) Drain valve with sampling device.
         3) Dial type thermometer.
         4) Pressure relief valve.
         5) Vacuum pressure gauge.
      c. Door to low-voltage section shall have a 3-point latching mechanism with pad-locking provision.
   9. Primary compartment:
      a. Enclose the high voltage bushings and provide for incoming cables from below the compartment:
         1) Coordinate primary bushing size with incoming cables size as indicated on the Drawings.
      b. Compartment shall also house:
         1) Dead front lightning arresters.
         2) No-load tap changer.
         3) Primary ON-OFF switch.
      c. Accessible only after the door for the secondary compartment has been opened. Door shall be held closed by a captive bolt; access to this bolt shall be provided only when the door to the low-voltage section is opened.
   10. Primary terminals and parking stands:
      a. Dead front construction, in accordance with IEEE C57.12.26, utilizing high voltage elbows for connections to primary cable and lightning arresters.
      b. Terminal arrangement with 6-bushing wells:
         1) 3 for terminating primary power cables.
         2) 3 for connecting lightning arresters.
         3) 6 parking stands.

c. Supporting structure within cabinet to support cables and eliminate mechanical stress on insulators.
d. Where indicated on the Drawings, provide oil-immersed fuses in the primary circuit.

11. Secondary terminals:
    a. 4 low voltage spade bushings with 2 holes for each cable, in accordance with IEEE C57.12.26.
    b. Extend low voltage bushings as necessary to accommodate the cable arrangement indicated on the Drawings or indicated on the conduit schedule:
        1) Extension via a fully rated, tin-plated, copper bus system braced to withstand the available fault current.
    c. Neutral brought out through an insulated bushing and externally grounded to the tank with a removable ground strap.
    d. Supporting structure within cabinet to support cables and eliminate mechanical stress on insulators.

D. De-energized tap changer:
1. Furnish with full capacity high-voltage taps:
    a. Two 2-1/2 percent taps above and below rated voltage.
2. Labeled to indicate that the transformer must be de-energized before operating the tap changer as required by IEEE C57.12.10.
3. Externally operated no-load tap changer switch with snap action switch and lever handle.
4. Padlocking provision in each tap position.
5. Position indication.

## 2.08 ACCESSORIES

A. Lightning arresters:
1. High voltage dead front design for elbow connection.
2. Metal oxide varistor arresters.
3. Distribution class arresters.
4. Rating as indicated on the Drawings and/or consistent with the distribution voltage.

B. Tank ground pads:
1. 2 stainless steel pads, welded to the tank wall, with unpainted surfaces:
    a. One pad in primary compartment.
    b. One pad in secondary compartment:
        1) If additional load ground connections are required, a tin-plated, copper equipment ground bus shall be bolted to the pad.

C. Dial-type thermometer:
1. Direct stem mounted in a closed well so that the thermometer can be removed without breaking the tank seal:
    a. Well shall be threaded into a fitting that is welded to the transformer tank wall.
2. Thermometer shall have a marking hand which is moved by the indicating hand to indicate maximum oil temperature:
    a. Marking hand shall be externally resettable.

D. Sampling device:
   1. Provide for external sampling of the transformer insulating fluid.
   2. Threaded into a fitting that is welded to the transformer tank wall.
   3. Piped such that valve and sample point are external to the termination cabinet:
      a. NEMA Type 4X stainless steel box supported to transformer to house sample device.

E. Liquid level gauge:
   1. Dial-type liquid level gauge.

F. Vacuum pressure gauge:
   1. 10 pounds per square inch gauge vacuum to plus 10 pounds per square inch gauge scale.

G. Pressure relief device:
   1. Located in the air space in the transformer tank to provide a method of relieving internal tank pressure.
   2. Self-relieving.
   3. Indicating.
   4. Operating pressure: 10 within 2 pounds per square inch gauge.

H. Nameplates:
   1. Provide nameplate as specified in Section 16075 - Identification for Electrical Systems and the following:
      a. Provide complete nameplates identifying equipment, caution, voltage, etc.
      b. Provide complete nameplates for both inside and outside of the transformer terminal compartments.
      c. Provide diagrammatic nameplate.

I. Bolted 8-inch (minimum) diameter round handhold on cover.

J. Lifting lugs at each corner of tank for lifting complete transformer.

K. Jacking facilities at each corner of base for jacking the complete transformer.

L. Base designed for rolling or skidding in any direction.

M. Bayonet-type fuse:
   1. Oil immersed expulsion type fuse with an interrupting rating of 3,800 A at 8.3 kV; 2,000 A at 15.5 kV.
   2. Hook stick-operable.
   3. Drawout.
   4. Load break design.
   5. 2 types of fuse links:
      a. Overload sensing; or
      b. Fault sensing.

N. Current limiting fuses:
   1. Submersible rated for oil immersion and series rated for use in series with the manufacturer’s selected bayonet fuse and to limit transformer primary short circuit current to 5,000 amps.

## 2.09 FABRICATION

A. Tanks:
   1. Construction: Sealed tank construction with welded cover. Permanently locate an inorganic gasket between the cover and the tank flange during the welding of the transformer cover to prevent the entrance of weld spatter into the tank.
   2. Large handhole with bolted cover and protected with a weather cover.
   3. Four lifting hooks.
   4. Jacking pads.
   5. Fluid sample valve.
   6. Designed for 7 pounds per square inch gauge without permanent distortion; 12 pounds per square inch gauge when silicone oil insulating fluid is specified.

## 2.10 FINISHES

A. In accordance with IEEE C57.12.28 including the following performance requirements:
   1. Salt spray test.
   2. Crosshatch adhesion test.
   3. Humidity test.
   4. Impact test.
   5. Oil resistance test.
   6. Ultraviolet accelerated weathering test.
   7. Abrasion resistance: Taber® Abraser.

B. Procedure:
   1. Clean with an alkaline cleaning agent to remove grease and oil.
   2. Chemically bond iron phosphate coating to metal surface to ensure coating adhesion and retard corrosion.
   3. Prime metal surface with an electrodeposited powder epoxy to provide a barrier against moisture, salt, and corrosives.
   4. Coat with an electrostatically applied, oven-cured polyester powder coat to enhance abrasion and impact resistance.
   5. Topcoat: Liquid polyurethane coating to seal and add ultraviolet protection:
      a. Color: Munsell Green 7GY.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish concrete pad and lugs, bolts, and other accessories needed to complete the installation of the transformer.
   2. Assemble and install the transformer in the location and layout indicated on the Drawings.
   3. Perform Work in accordance with manufacturer’s instructions and Shop Drawings.
   4. Raise the tank above the pad to protect the bottom finish during installation and to minimize corrosion due to moisture accumulation.
   5. Furnish components and equipment as required to complete the installation.
   6. Replace any hardware lost or damaged during installation or handling.
   7. Position the transformer so required working space and clearance requirements of the NEC and the local building authorities are met.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Perform the following factory tests as required by IEEE C57.12.00 and in accordance with IEEE C57.12.90:
      a. No-load (85 degrees Celsius) losses at rated current. (Maximum allowable no-load losses: 10 percent).
      b. Total (85 degrees Celsius) losses at rated current. (Maximum allowable total losses: 6 percent).
      c. Percent impedance (85 degrees Celsius) at rated current.
      d. Excitation current (100 percent voltage) test.
      e. Winding resistance measurement tests.
      f. Turns ratio tests using tap settings.
      g. Polarity and phase relation tests.
      h. Temperature test.
   2. Furnish test reports and Manufacturer’s Certificate of Source Testing.

C. Installation Verification:
   1. Furnish Manufacturer’s Certificate of Installation Verification.

D. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL

A. Provide the services of a manufacturer’s authorized representative:
   1. Inspect installation before start-up.
   2. Witness energization.

B. Energize transformer according to the manufacturer’s recommended procedure and in accordance with IEEE C57.91.

## 3.06 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

END OF SECTION

## SECTION 16285

## SURGE PROTECTIVE DEVICES

### PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. High-energy surge protective devices.

### 1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
   2. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and Less) AC Power Circuits.
   3. C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
   4. C62.62- Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1,000 V and less) AC Power Circuits.

B. International Electrotechnical Commission (IEC).

C. National Electrical Manufacturers Association (NEMA).

D. National Fire Protection Agency (NFPA):
   1. 20 - Standard for the Installation of Stationary Pumps for Fire Protection.
   2. 70 - National Electric Code (NEC).
   3. 75 - Standard for the Fire Protection of Information Technology Equipment.
   4. 780 - Standard for the Installation of Lightning Protection Systems.

E. Underwriters Laboratory (UL):
   1. 96A - Standard for Installation Requirements for Lightning Protection Systems.
   2. 1283 - Standard for Electromagnetic Interference Filters.
   3. 1449 - Standard for Surge Protective Devices.

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. $I_n$: Nominal discharge current.
   2. MCOV: Maximum continuous operating voltage.
   3. MOV: Metal oxide varistor.
   4. SAD: Silicon avalanche diode.
   5. SCCR: Short circuit current rating.
   6. SPD: Surge protective device.

7. VPR: Voltage protection rating.

## 1.04 DELEGATED DESIGN (NOT USED)

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
   2. Manufacturer's catalog cutsheets indicating:
      a. Manufacturer and model numbers.
      b. Ratings of each SPD, including, but not limited to:
         1) Short circuit current rating.
         2) Nominal discharge current.
         3) Maximum continuous operating voltage.
         4) Voltage protection rating.
         5) System voltage.
         6) System frequency.
         7) Surge current capacity.
   3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
      a. Overcurrent protection.
      b. UL 1449.

C. Shop Drawings:
   1. Provide electrical and mechanical drawings by the manufacturer that detail:
      a. Unit dimensions.
      b. Weights.
      c. Components.
      d. Field connection locations.
      e. Mounting provisions.
      f. Connection details.
      g. Wiring diagram.

D. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Certificates:
         1) Requirements as specified in this Section.
      b. Test Plans:
         1) Test requirements as specified in this Section.
      c. Test Reports.
      d. Owner Training.

E. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Include a list of configurable parameters and the final values for each.
   3. Include a troubleshooting chart covering the complete valve and controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.

## 1.06 QUALITY ASSURANCE

A. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. IEEE C62.41.1, C62.41.2, C62.45, C62.62.
   2. Federal Information Processing Standards Publication 94 (FIBS PUB 94).
   3. NEMA.
   4. NFPA 20, 70, 75 and 780.
   5. UL 1449 current edition and UL 1283.

B. IEC 801.

C. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B and C3 environments, as tested to IEEE C62.45.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Extended warranty:
   1. Furnish a manufacturer’s standard parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer’s written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
   2. Warranty shall include:
      a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
      b. A 24-hour toll-free 800-number for warranty support.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide surge protection as indicated on the Drawings.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Southern Tier Technologies.
   4. Schneider Electric.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.

B. Electrical requirements:
   1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
   2. MCOV:
      a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
   3. Operating frequency:
      a. 47 to 63 hertz.
   4. SCCR:
      a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
      b. Marked on the SPD in accordance with UL 1449 and the NEC.
   5. Nominal discharge current $I_n$:
      a. 20 kA.
   6. Maximum VPR:

| Modes | 240/120 3W | 208Y/120 | 480Y/277 | 480 V |
|---|---|---|---|---|
| L-N, L-G, N-G | 700 | 700 | 1,200 | 1,800 |
| L-L | 1,200 | 1,200 | 2,000 | 1,800 |

   7. Peak surge current:
      a. Service entrance locations:
         1) 240 kA per phase minimum.
         2) 120 kA per mode minimum.
      b. Branch locations:
         1) 120 kA per phase, minimum.
         2) 60 kA per mode minimum.

C. Protection modes:
   1. Provide SPD protection modes as follows:
      a. Line to Neutral (L-N) where applicable.
      b. Line to Ground (L-G).
      c. Neutral to Ground (N-G), where applicable.

D. Environmental requirements:
   1. Storage temperature:
      a. -40 to 122 degrees Fahrenheit.
   2. Operating temperature:
      a. 32 to 140 Fahrenheit.
   3. Relative humidity:
      a. 5 to 95 percent.
   4. Audible noise:
      a. Less than 45 dBa at 5 feet (1.5 m).
   5. Operating altitude:
      a. Zero to 12,000 feet above sea level.

## 2.07 COMPONENTS

A. Enclosure:
   1. Located in electrical equipment as indicated on the Drawings.

B. Internal connections:
   1. Provide low impedance copper plates for intra-unit connections:
      a. Attach surge modules using bolted connections to the plates for low impedance connections.
   2. Size connections, conductors, and terminals for the specified surge current capacity.

C. Surge diversion modules:
   1. MOV:
      a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer’s defects.

D. Overcurrent protection:
   1. Individually fuse components, including suppression, filtering, and monitoring components:
      a. Rated to allow maximum specified nominal discharge current capacity.
      b. Overcurrent protection that limits specified surge currents is not acceptable.

E. Connections:
   1. Provide terminals to accommodate wire sizes up to #2 AWG.

## 2.08 ACCESSORIES

A. Unit status indicators:
   1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
      a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
      b. Indicates the status of protection on each mode or phase.

B. Dry contacts for remote monitoring:
   1. Electrically isolated Form C dry contacts (1 A/125 VAC, or 2 A/24 VDC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide an audible alarm which activates under any fault condition:
   1. Alarm On/Off switch to silence the alarm.
   2. A visible LED will confirm whether alarm is On or Disabled.
   3. Locate both switches and the audible alarm on the unit’s front cover.

D. Provide transient counter to count transient voltage surges:
   1. LCD readout located on the unit’s front cover.
   2. Counter to utilize batteries with a 10-year nominal life or non-volatile memory to maintain accurate counts in the event of power loss.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES (NOT USED)

## 2.11 SOURCE QUALITY CONTROL

A. Permanently affix surge rating to the SPD.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION (NOT USED)

## 3.03 INSTALLATION

A. Follow the manufacturer’s recommended installation practices and comply with all applicable codes.

B. Special techniques:
   1. Install SPDs internal to equipment with as short and straight conductors including ground conductor as practically possible:
      a. Twist the input conductors together to reduce input conductor inductance.
   2. Do not subject SPD to insulation resistance testing.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Perform manufacturer’s standard factory test:
      a. Perform testing in accordance with UL 1449.
   2. Furnish test reports and Manufacturer’s Certificate of Source Testing.

C. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

D. Owner Training:
   1. Not required.

END OF SECTION

SECTION 16290

ELECTRICAL POWER MONITORING

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
  1. Power meters and accessories.

## 1.02 REFERENCES

A. Definitions:
  1. FS - Full Scale.
  2. RDG - Of Reading.
  3. SSM - Solid State Multifunction Power Meter.
  4. THD - Total Harmonic Distortion.

B. Standards:
  1. American National Standard Institute (ANSI):
     a. C12.20 - Electricity Meters - 0.2 and 0.5 Accuracy Classes.
  2. Institute of Electrical and Electronics Engineers (IEEE):
     a. C57.13.6 - Standard for High Accuracy Instrument Transformers.

## 1.03 DELEGATED DESIGN (NOT USED)

## 1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
  1. Power meter data including but not limited to:
     a. Power requirements.
     b. Communications protocols.
     c. Input/outputs.
     d. Dimensions.
     e. Measurement functions.
     f. Front panel controls.
     g. Display characteristics.
  2. Accessory data:
     a. Test switch dimensions and wiring diagrams.

C. Commissioning submittals:
  1. As specified in Section 01756 - Commissioning, including the following:
     a. Owner training.

D. Operation and maintenance manuals:
   1. Descriptive and technical bulletins and sales aids edited to reflect only the equipment to be provided and covering each of the components in the system.
   2. A maintenance section including all instruction leaflets and technical data necessary to setup, change setup and maintain the power meters.
   3. Original licensed copies of all software and software manuals.

E. Configuration files and reports:
   1. Settings including but not limited to:
      a. Device tag name.
      b. IP addresses.
      c. Alarm settings.
      d. Time synchronization settings.
      e. Security settings.
   2. Configuration files are to be provided in the selected manufacturer's native format.
   3. Configuration reports are to be submitted in .PDF format, listing each configured parameter setting and description of each parameter.

**1.05 QUALITY ASSURANCE (NOT USED)**

**1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)**

**1.07 PROJECT OR SITE CONDITIONS**

A. As specified in Section 01850 - Design Criteria.

**1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)**

**1.09 WARRANTY**

A. As specified in Section 01783 - Warranties and Bonds.

**PART 2 PRODUCTS**

**2.01 GENERAL (NOT USED)**

**2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)**

**2.03 MANUFACTURERS**

A. The following, no equal:
   1. Schweitzer Engineering Laboratories, SEL-735.

**2.04 MATERIALS (NOT USED)**

**2.05 MANUFACTURED UNITS (NOT USED)**

**2.06 EQUIPMENT (NOT USED)**

## 2.07 COMPONENTS

A. Power meters:
   1. Power meter type 1 (SSM1) device which shall include at a minimum:
      a. Individual phase currents, plus or minus 0.5 percent FS.
      b. Phase-to-phase and phase-to-neutral voltages, plus or minus 0.5 percent FS.
      c. Watts, VARs, VA, plus or minus 1 percent FS.
      d. Watt-hours, VAR-hours, VA-hours, plus or minus 1 percent FS.
      e. PF (apparent and displacement), plus or minus 2 percent FS.
      f. Frequency, plus or minus 1 percent hertz.
      g. Demand:
         1) Ampere, plus or minus 0.5 percent full scale.
         2) Watt, VAR, VA, plus or minus 1 percent full scale.
      h. Minimum and maximum values:
         1) Volts (L-L), volts (L-N), current, watts, VARS, VA.
         2) Power factor:
            a) Apparent.
            b) Displacement.
            c) Frequency.
      i. Synch-input kilowatts utility.
      j. LCD with LED backlight.

## 2.08 ACCESSORIES

A. Current transformers:
   1. Ring type current transformers:
      a. Suitable for service within low or medium voltage equipment as indicated on the Drawings.
      b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the equipment of the application.
   2. Current ratio: As indicated on the Drawings.
   3. Rated in accordance with IEEE C57.13.6 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
   4. Identify polarity with standard marking or symbols.
   5. Capable of carrying rated primary current continuously without damage.
   6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. Install power meters in accordance with the manufacturer's instructions in the electrical equipment as indicated on the Drawings.

### 3.04 COMMISSIONING

A. General:
   1. As specified in Section 01756 - Commissioning.

B. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

C. Owner Training:
   1. Not required.

END OF SECTION

## SECTION 16305

## ELECTRICAL SYSTEM STUDIES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Short-circuit fault analysis studies.
   2. Protective device coordination study.
   3. Arc-flash hazard study.

### 1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 1584 - IEEE Guide for Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculation Study in Accordance with IEEE Std 1584.

C. National Fire Protection Association (NFPA):
   1. 70E - Standard for Electrical Safety in the Workplace.

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Modified: Equipment with load additions or with loads being removed that affect fault current, include new overcurrent protective devices that require settings and device coordination, or require additional/removal/replacement of arc flash labels.

### 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Signed and Sealed electrical system study reports.

### 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Credentials of the individual(s) performing the study and the individual in responsible charge of the study.

C. General:
   1. Format and quantity:
      a. 6 bound copies of all final reports.

b. 3 complete sets of electronic files on CD or DVD media, including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports. Also provide an electronic version of the bound reports in PDF format.

2. One-line diagrams:
   a. The following information shall be included at a minimum:
      1) Motor horsepower.
      2) Transformer data:
         a) kVA.
         b) Configuration.
      3) Cable data:
         a) Insulation.
         b) Size.
         c) Length.
   b. Fully legible at 11-inch by 17-inch size.

D. Initial short-circuit fault analysis:
   1. Based on the Contract Documents and electric utility information.
   2. Include a description of all operating scenarios.
   3. One-line diagrams.
   4. Indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study.
      a. Measure conductor lengths from the Drawings. Use of arbitrary short conductor lengths is not allowed.
      b. Provide a list of assumptions used in the initial study.

E. Delegated Design final studies and reports:
   1. Include the following sections at a minimum:
      a. Copies of correspondence and data obtained from the electric utility company.
      b. Letter certifying the inspection and verification of existing equipment and incorporation of applicable RFI's and change orders.
      c. Short-circuit fault analysis:
         1) Modify the initial short-circuit fault analysis as follows:
            a) Utilize the actual equipment provided on the project.
            b) Utilize conductor lengths based on installation.
            c) Update one-line diagrams to show as-built conditions.
         2) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
         3) Normal system connections and those that result in maximum fault conditions.
         4) Tabulation of circuit breaker, fuse, and other protective device ratings compared to maximum calculated short-circuit duties.
         5) Fault current calculations for the cases run including a definition of terms and guide for interpretation of computer software printouts.
      d. Protective device coordination study shall include:
         1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
         2) List requirements used in the selection and setting criteria for any protective devices.

3) Manufacturer’s time-current curves for circuit breakers, fuses, motor circuit protectors, and other protective devices for new equipment.
4) TCCs graphically indicating the coordination proposed for the system on log-log graphs:
    a) All TCCs shall be in color.
5) Tabulation of relay, fuse, circuit breaker, and other protective devices in graphical form with a one-line diagram to display area coordination.
6) Where coordination could not be achieved, an explanation shall be included in the report to support the statement along with recommendations to improve coordination. Recommended equipment modifications or settings shall be in a tabulated form.
7) Protective device settings in a tabulated format.

e. Include in the arc-flash hazard study:
    1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
    2) Normal system connections and those that result in maximum arc-flash conditions.
    3) Arc-flash raw data, calculations, and assumptions.

f. Form and format of arc-flash labels.
    1) Label data:
        a) Identifying the content of each label.
        b) Identifying the location of each label.

F. Submit course outline for Owner Training.

## 1.06 QUALITY ASSURANCE

A. Qualifications of the entity responsible for electrical system studies:
1. A minimum of 5 years of experience in power system analysis is required for the individual in responsible charge of the studies.
2. Short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall be performed with the aid of a digital computer program:
    a. Point-to-point calculations are not acceptable.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS (NOT USED)

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
1. The individual performing the studies shall visit the site and collect necessary field data in order to perform and complete comprehensive electrical system studies.
2. Obtain, for all equipment, the required data for preparation of the study, including, but not limited to:
    a. Transformer kilovolt-ampere (kVA), nameplate data, and impedances.
    b. Generator impedances, kilovolt-ampere (kVA), and voltage.
    c. Generator decrement curves.
    d. Bus withstand ratings.
    e. Cable and bus data.

f. Protective device taps, time dials, instantaneous pickups, and time-delay settings.
g. As-built lengths for new wire and cable installations covered by the studies.
h. Grounding schemes (solidly grounded or resistive grounded).

3. Obtain the electric utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:
   a. Utility tolerances and voltage variations.
   b. Coordinate with the utility for changes to their protective devices and settings to achieve a coordinated system between the utility and the Owner.
4. Obtain equipment layouts and configurations from the manufacturer's final Submittal requirements and Project layout drawings as required.
5. Bus and conductor data:
   a. Use impedances of the actual installed or specified conductors, unless otherwise indicated.
   b. Use cable and bus impedances calculated at 25 degrees Celsius, unless otherwise indicated.
   c. Use 600-volt cable reactance based on typical dimensions of actual installed or specified conductors, unless otherwise indicated.
   d. Use bus withstand values for all equipment having buses.

B. Use medium-voltage cable reactance based on typical dimensions of shielded cables with 133 percent insulation levels, unless otherwise indicated.

C. Certification:
   1. Submit written certification signed by the professional engineer conducting the study, equipment supplier, and electrical subcontractor, stating that the data used in the study is correct and captures all RFIs, as-builts, and change orders affecting the study.

D. Meetings:
   1. Electrical system study meetings:
      a. As specified in Section 01312 - Project Meetings.
      b. The individual conducting the electrical system studies leads the meeting.
      c. Meet with the Owner and Engineer 3 times.
      d. First meeting:
         1) Discuss the scope of the studies.
         2) Confirm electrical system operating modes.
         3) Confirm assumptions to be used in the electrical system study with the Owner, including, but not limited to:
            a) Maximum protective device fault clearing time.
         4) Discuss the Owner's operational requirements for both normal operation and maintenance.
      e. Second meeting:
         1) Inform the Owner of the results of the study and impacts on normal operation and maintenance including:
            a) Protective device coordination problems and recommended solutions.
            b) Explanation of the arc-flash hazard study results and its potential impact on operations.

c) Recommendations for reduction of arc-flash category levels including reduction of protective device settings or changes in operational practices.

f. Final meeting:
   1) Prior to substantial completion.
   2) Discuss changes to the studies based on the previous meeting.
   3) Discuss with the Owner how changes to the electrical system may change the arc-flash hazard category.

E. Sequencing:
1. Below is an outline of the typical work sequence. Proposed changes to the work sequence may be reviewed and approved by the Engineer.
   a. First system study meeting.
   b. Submit the initial short-circuit fault analysis study before submittal of any electrical equipment.
      1) Only the initial short-circuit results will be reviewed.
   c. Site visit to gather data on the existing facility systems for all studies:
      1) Make multiple trips as required to obtain data for the short-circuit fault analysis, protection device coordination, and arc flash hazard studies.
   d. Submit the preliminary short-circuit fault analysis, protective device coordination, and arc-flash hazard studies after the approval of all electrical equipment.
   e. Second system study meeting for preliminary results.
   f. Update the model with changes to the electrical system made during start-up and commissioning.
   g. Final system study meeting.
   h. Submit the final electrical system studies.
   i. Label equipment with approved arc-flash labels.
   j. Owner Training.

## PART 2 PRODUCTS

### 2.01 GENERAL (NOT USED)

### 2.02 DESIGN AND PERFORMANCE CRITERIA

A. General study requirements:
1. Scope:
   a. Short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall include all equipment in the power distribution system, including, but not limited to:
      1) Utility equipment (utility transformer and primary protective device).
      2) Available utility fault contribution current.
      3) All electrical equipment including:
         a) Dry-type transformers.
         b) 240- and 208-volt panelboards.
      4) Generators.
      5) Motors.
      6) Vendor control panels.

7) HVAC equipment.
b. Study scenarios:
1) Include all possible electrical system configurations, for example:
a) Operation on normal (utility) source.
b) Operation on generator source.
c) Main-breakers closed; tie-breaker open.
d) Either main-breaker open; tie-breaker closed.
2. Motors:
a. Each motor shall be individually modeled:
1) Grouping of motors for fault contribution current is not acceptable.
b. Motors with variable frequency drives (VFDs) may be assumed to have no contribution to fault current, unless VFDs are equipped with bypass contactors.
1) If VFDs are equipped with bypass contactors, perform the fault current and arc flash study assuming 1 of bypass contactors are in the closed position.
3. Use the equipment, bus, and device designations as indicated on the Drawings for all studies.

B. Short-circuit fault analysis study additional requirements:
1. Calculate 3-phase bolted fault, line-to-line fault, line-to-ground fault, double line-to-ground fault, short-circuit 1/2 cycle momentary symmetrical and asymmetrical RMS, 1-1/2 to 4 cycle interrupting symmetrical RMS, and 30-cycle steady-state short-circuit current values at each piece of equipment in the distribution system.
2. Evaluate bus bracing, short-circuit ratings, fuse interrupting capacity and circuit-breaker-adjusted interrupting capacities against the fault currents, and calculate X/R values:
a. Identify and document all devices and equipment as either inadequate or acceptable.
3. Calculate line-to-ground and double line-to-ground momentary short-circuit values at buses having ground-fault devices.
4. Provide calculation methods, assumptions, one-line diagrams, and source impedance data, including utility X/R ratios, typical values, recommendations, and areas of concern.

C. Protective device coordination study additional requirements:
1. Furnish protective device settings for functions indicated on the Drawings, including, but not limited to:
a. Current.
2. Provide log-log form time-current curves (TCCs) graphically indicating the coordination proposed for the system:
a. Include with each TCC a complete title and one-line diagram with legend identifying the specific portion of the system covered by the particular TCC:
1) Typical TCCs for identical portions of the system, such as motor circuits, are acceptable as allowed by the Engineer.
b. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics:
1) These details can be included on the TCC.

c. Include a detailed description of each protective device tap, time dial, pickup, instantaneous, and time delay settings:
   1) These details can be included on the TCC.
3. TCCs shall include all equipment in the power distribution system where required to demonstrate coordination. Include utility relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, transformer characteristics, motor and generator characteristics, and characteristics of other system load protective devices:
   a. Include devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, main breaker in branch panelboards, and fused disconnect switches.
   b. Provide ground fault TCCs with adjustable settings for ground fault protective devices.
   c. Include manufacturing tolerances and damage bands in plotted fuse and circuit breaker characteristics.
   d. On the TCCs, show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and transformer damage curves.
   e. Cable damage curves.
   f. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed based on the short-circuit fault analysis study.
   g. Coordinate time interval medium-voltage relay characteristics with upstream and downstream devices to avoid nuisance tripping.
4. Site generation: When site generation (including cogeneration, standby, and emergency generators) is part of the electrical system, include phase and ground coordination of the generator protective devices:
   a. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices.
5. Suggest modifications or additions to equipment rating or settings in a tabulated form.

D. Arc-flash hazard study additional requirements:
1. Include the calculated arc-flash boundary and incident energy (calories/square centimeter) at each piece of equipment in the distribution system:
   a. Perform study with 15 percent arcing fault variation in accordance with IEEE 1584.
   b. Perform arc-flash calculations at minimum and maximum utility and generator fault contributions.
   c. Perform arc-flash calculations for both the line side and load side of the switchgear, switchboard, motor control center, and panelboard main breakers.
   d. Perform arc-flash calculations for short-circuit scenarios with all motors on for 3 to 5 cycles and with all motors off.
2. Provide executive summary of the study results:
   a. Provide summary based upon worst case results.
3. Provide a detailed written discussion and explanation of the tabulated outputs:
   a. Include all scenarios.

4. Provide alternative device settings to allow the Owner to select the desired functionality of the system:
    a. Minimize the arc-flash energy by selective trip and time settings for equipment maintenance purposes.
    b. Identify the arc-flash energy based upon the criteria of maintaining coordination and selectivity of the protective devices.

## 2.03 MANUFACTURERS

A. Update the Owner’s existing SKM Systems Analysis, Powertools electrical system studies.

## 2.04 EXISTING PRODUCTS (NOT USED)

## 2.05 MATERIALS (NOT USED)

## 2.06 MANUFACTURED UNITS (NOT USED)

## 2.07 EQUIPMENT (NOT USED)

## 2.08 COMPONENTS

A. Arc-flash hazard labels:
    1. Dimensions:
        a. Minimum 5 inches by 3.5 inches.
    2. Materials:
        a. Polyester with polyvinyl polymer over-laminate.
        b. Self-adhesive.
        c. Resistant to:
            1) UV.
            2) Chemicals and common cleaning solvents.
            3) Scuffing.
            4) Wide temperature changes.
    3. Contents:
        a. Short-circuit bus identification.
        b. Calculated incident energy (calories/square centimeter) range:
            1) Based on worst-case study results.
        c. Arc-flash protection boundary.
        d. Shock hazard boundary:
            1) Contractor may provide separate labels for indication of the shock hazard boundary.
        e. Fed from:
            1) Identify the tag number of the upstream equipment providing power.
    4. Color scheme:
        a. For locations above 40 calories/square centimeter:
            1) White label with red “DANGER” strip across the top.
            2) Black lettering.
        b. For locations below 40 calories/square centimeter:
            1) White label with orange “WARNING” strip across the top.
            2) Black lettering.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. After review and acceptance of the arc-flash hazard study by the Engineer, install arc-flash hazard labels:
   1. At all locations required by NFPA, ANSI, or IEEE standards.
   2. At a minimum, in the following locations:
      a. Front of each main or incoming service compartment.
      b. Front of each low-voltage switchgear section.
      c. Front of each medium-voltage circuit breaker door.
      d. Front of each accessible auxiliary or conductor compartment.
      e. Each accessible rear or side vertical section.
      f. Each motor control center vertical section.
      g. Each panelboard covered by the study.
      h. Each control panel, individual starter or VFD, or other equipment covered by the scope of the study.

### 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Owner Training:
   1. Including, but not limited to:
      a. Introduction and basics of NFPA 70E: 2 hours 2 sessions.
      b. Detailed review of the electrical system study: 2 hours 1 session.

### 3.05 FIELD QUALITY CONTROL

A. Individual performing the arc-flash hazard study shall direct the installation of the arc-flash hazard labels:
   1. Remove and replace any improperly applied labels.
   2. Repair the equipment finish damaged by removal of any label.
   3. Install labels level or plumb across the entire dimension of the label.

### 3.06 ADJUSTING

A. After review and acceptance of the draft arc-flash hazard study and protective device coordination study by the Engineer, adjust protective device settings in accordance with final study prior to equipment energization.
   1. Devices that require power for configuration may be set during energization, but before any subfed loads are energized.
   2. Ensure that settings for upstream equipment are set prior to energizing downstream devices. Provide documentation that protective devices are set in accordance with the study recommendation.

END OF SECTION

## SECTION 16411

## DISCONNECT SWITCHES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Knife blade fusible and non-fusible disconnect switches.
   2. Switch-rated plugs and receptacles.

### 1.02 REFERENCES

A. National Electric Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. KS 1-2001 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. Underwriters Laboratories Inc. (UL):
   1. 98 - Enclosed and Dead-Front Switches.

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Safety switches and disconnect switches are to be considered synonymous.

### 1.04 DELEGATED DESIGN (NOT USED)

### 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Manufacturer’s specifications and description.
   3. Ratings:
      a. Voltage.
      b. Current.
      c. Horsepower.
      d. Short circuit rating.
   4. Fused or non-fused.
   5. NEMA enclosure type.
   6. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   7. Weight.

8. Cross-referenced to the disconnect schedule indicated on the Drawings.

C. Shop Drawings:
   1. Manufacturer's installation instructions:
      a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance, Regulatory Requirements below.
      b. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
   2. For each switch, indicate nameplate inscription, including voltage, circuit, fuse size (if applicable), and equipment served.

D. Installation instructions:
   1. Provide manufacturer's installation instructions.

## 1.06 QUALITY ASSURANCE

A. Regulatory requirements:
   1. NEMA Type KS 1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).
   2. UL 98 - Enclosed and Dead-Front Switches.

B. Disconnect switches shall be UL listed and labeled.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for Engineer's review.
   2. After successful review of the initial fault current study, submit complete equipment Submittal.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide knife blade disconnect switches and switch-rated plugs and receptacles as indicated on the Drawings and specified in the Contract Documents.

B. Provide equipment with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

## 2.03 MANUFACTURERS

A. Knife-blade disconnect switches:
   1. One of the following or equal:
      a. ABB.
      b. Appleton.
      c. Crouse-Hinds.
      d. Eaton.
      e. Schneider Electric.
      f. Siemens.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Knife-blade style switch disconnects:
   1. Switch mechanism:
      a. Quick-make, quick-break heavy-duty operating mechanisms:
         1) Provisions for padlocking the switch in the Off position.
         2) A minimum of 90-degree handle travel position between Off and On positions:
            a) Provide handle position indicators to identify the handle position.
         3) Full cover interlock to prevent opening of the switch door in the On position and to prevent closing the switch mechanism with the door open:
            a) With an externally operated override.
   2. Switch interior:
      a. Switch blades visible when the switch is Off and the cover is open.
      b. Lugs:
         1) Front accessible.
         2) Removable.
         3) UL listed for 60/75-degree Celsius copper conductors.
      c. Current carrying parts completely plated to resist corrosion.
      d. Removable arc suppressors to facilitate easy access to line side lugs.
      e. Furnish equipment ground kits for every switch.
   3. Fused switches:
      a. Furnish with fuses as indicated on the Drawings:
         1) Provide fuses as specified in Section 16494 - Low Voltage Fuses.
      b. UL approved for field conversion from standard Class H fuse spacing to Class J fuse spacing:
         1) Ratings 100 amps through 600 amps at 240 volts.
         2) Ratings 30 amps through 600 amps at 600 volts.
         3) Provide spring reinforced and plated fuse clips.
   4. Ratings:
      a. UL horsepower rated for AC or DC with the rating not less than the load served.

b. Current:
   1) 30 to 1,200 amps.
c. Voltage:
   1) 250 volts AC, DC.
   2) 600 volts (30 A to 200 A, 600 volts DC).
d. Poles:
   1) 2, 3, 4, and 6 poles.
e. UL listed short circuit ratings:
   1) 10,000 RMS symmetrical amps when used with or protected by Class H or K fuses (30 to 600 amps).
   2) 200,000 RMS symmetrical amps when used with or protected by Class R or J fuses (30 to 600 amps employing appropriate fuse rejection).
   3) 200,000 RMS symmetrical amps when used with or protected by Class L fuses (800 to 1,200 amps).

B. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 16050 - Common Work Results for Electrical for the installed location.

C. Size, fusing and number poles as indicated on the Drawings or as required:
   1. Provide solid neutral where indicated on the Drawings.

## 2.07 COMPONENTS (NOT USED)

## 2.08 ACCESSORIES

A. Disconnect switches to have provisions for a field installable “B” type electrical interlock for position indication as indicated on the Drawings.

B. Disconnect switches to have provisions for a field installed insulated groundable neutral kit as indicated on the Drawings.

C. NEMA Type 7 and Type 9 enclosures furnished with drain and breather kit when used in outdoor applications.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
  1. Use Myers hubs or bolt-on hubs for conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.
  2. Provide mounting brackets, stands, supports and hardware as required:
     a. Match finish and materials for brackets, stands, and hardware with the switch installed.
     b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.
  3. When possible, mount switches rigidly to exposed building structure or equipment structural members:
     a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.
     b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.
  4. Provide a nameplate for each disconnect switch:
     a. As specified in Section 16075 - Identification for Electrical Systems.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
  1. As specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

END OF SECTION

# SECTION 16412

# LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Low voltage molded case circuit breakers.

### 1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

B. Underwriter's Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

### 1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Manufacturer's time-current curves for molded case circuit breakers furnished.

C. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Owner Training.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

### 1.05 QUALITY ASSURANCE

A. Low voltage molded case circuit breakers shall be UL listed and labeled.

## 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Molded case thermal magnetic, solid-state, or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

## 2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

## 2.03 MANUFACTURERS

A. One of the following or equal:
  1. ABB.
  2. Eaton.
  3. Schneider Electric.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS

A. General:
  1. In accordance with UL 489.
  2. Operating mechanism:
     a. Quick-make, quick-break, non-welding silver alloy contacts.
     b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
     c. Mechanically trip free from the handle.
     d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
     e. Lockable in the “OFF” position.
  3. Arc extinction:
     a. In arc chutes.
  4. Voltage and current ratings:
     a. Minimum ratings as indicated on the Drawings.
     b. Minimum frame size 100A.
  5. Interrupting ratings:
     a. Minimum ratings as indicated on the Drawings.

b. Modify as required to meet requirements of the short circuit fault analysis as specified in Section 16305 - Electrical System Studies.
c. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.).

B. Motor circuit protectors:
1. Instantaneous only circuit breaker as part of a listed combination motor controller.
2. Each pole continuously adjustable in a linear scale with ‘LO’ and ‘HI’ settings factory calibrated.

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS

A. Terminals:
1. Line and load terminals suitable for the conductor type, size, and number of conductors indicated on the Drawings and in accordance with UL 489.

B. Case:
1. Molded polyester glass reinforced.
2. Ratings clearly marked.

C. Trip units:
1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
2. Thermal magnetic:
   a. Instantaneous short circuit protection.
   b. Inverse time delay overload.
   c. Ambient or enclosure compensated by means of a bimetallic element.
3. Solid state:
   a. With the following settings as indicated on the Drawings:
      1) Adjustable long time current setting.
      2) Adjustable long time delay.
      3) Adjustable short time pickup.
      4) Adjustable short time delay.
      5) Adjustable instantaneous pickup.
   b. 24 VDC power for trip unit:
      1) Unless otherwise noted, manufacturer shall provide bucket or unit mounted disconnect enclosure for control power transformer and 24 VDC UPS power supplies for advanced trip units. Provide Phoenix Contact “Trio-UPS” or equal.
   c. Energy reducing maintenance switch on breakers 1,200 amps and above and on additional breakers as indicated on the Drawings.
      1) Indication on the breaker.

D. Provide ground fault trip devices as indicated on the Drawings.

E. Molded case circuit breakers for use in panelboards:
1. Bolt-on type:
   a. Plug-in type breakers are not acceptable.
2. Ground fault trip devices as indicated on the Drawings.

## 2.08 ACCESSORIES

A. Key interlocks:
   1. Provide key operated interlocks to ensure safe switching procedures as indicated on the Drawings.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES (NOT USED)

## 2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
   1. UL 489.
   2. Manufacturer’s standard testing procedures.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install breakers to correspond to the accepted Shop Drawings.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

C. Owner Training:
   1. Not required.

## 3.05 FIELD QUALITY CONTROL (NOT USED)

## 3.06 ADJUSTING

A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with manufacturer’s recommendations.

B. Adjust motor circuit protectors in accordance with NEC and the manufacturer’s recommendation based on the nameplate values of the installed motor.

END OF SECTION

SECTION 16413

LOW VOLTAGE INSULATED CASE CIRCUIT BREAKERS

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Low voltage insulated case circuit breakers.

## 1.02 REFERENCES

A. Underwriters Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

## 1.03 DELEGATED DESIGN (NOT USED)

## 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cutsheets.
   2. Manufacturer’s time-current curves for all trip devices furnished.

C. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

## 1.05 QUALITY ASSURANCE

A. Insulated case circuit breakers shall be UL listed and labeled.

## 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. Insulated case circuit breakers as indicated on the Drawings and connect to form a completed system:
   1. Used to open and close a circuit, and to open a circuit automatically on a predetermined overload or overcurrent, without damage to itself when properly applied within its ratings.

### 2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

### 2.03 MANUFACTURERS

A. One of the following, or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

### 2.04 MATERIALS (NOT USED)

### 2.05 MANUFACTURED UNITS

A. Operating mechanism:
   1. Manual or electric as indicated on the Drawings:
      a. Manual operation:
         1) Circuit breaker closing spring is energized by no more than 6 operations of the constant-force charging handle.
         2) Pushing the “CLOSE (ON)” button will close the breaker’s contacts and pushing the “OPEN (OFF)” button will open the breaker’s contacts.
         3) Opening springs are automatically charged when the breaker is closed.
      b. Quick-make, quick-break, non-welding silver alloy contacts.
      c. Common trip, open and close for multi-pole breakers such that all poles open and close simultaneously.
      d. Mechanically trip free from the handle.
      e. Trip indicating handles - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
      f. Lockable in the “OFF” position.

B. Arc extinction:
   1. In arc chutes.

C. Voltage and current ratings:
   1. Minimum ratings as indicated on the Drawings.

D. Interrupting ratings:
   1. Minimum ratings as indicated on the Drawings:
      a. Modify as required to meet requirements of the Contractor’s Short Circuit Fault Analysis as specified in Section 16305 - Electrical System Studies.
   2. Matching the rating of the assembly.

E. Circuit breaker mounting shall be as indicated on the Drawings and consist of one of the following configurations:
   1. Draw out type capable of being racked to the disconnect position with the door closed:
      a. Interlocks shall be provided to prevent connecting or disconnecting the circuit breaker unless the breaker is in the open position.
      b. Breaker shall be prevented from being closed during any racking operation.
      c. A test position shall be provided to permit operating the breaker while it is disconnected from the power circuit.
      d. Equipped with interlocks to discharge stored energy spring before the circuit breaker is withdrawn from the cell.
   2. Plug-in (stationary) type capable of being removed with the main bus power off.
   3. Individually mounted in a separate enclosure.

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS

A. Terminals:
   1. Line and load terminals suitable for the conductor type, size, and number of conductors indicated on the Drawings and in accordance with UL 489.

B. Case:
   1. Molded polyester glass reinforced.
   2. Double level of insulation between primary current-carrying parts and operating personnel.
   3. Ratings clearly marked.
   4. Open contact indication.
   5. Closed contact indication.
   6. Charging spring charged indication.
   7. Charging spring discharged indication.
   8. Open pushbutton.
   9. Close pushbutton.
   10. Retractable charging handle.

C. Trip units:
   1. Microprocessor based with positive action flux-shifting trip device and a solid state type with the following functions:
      a. Adjustable ampere setting:
         1) To determine the value of current that the breaker will carry indefinitely.
      b. Adjustable long time delay:
         1) Varies the time it will take the breakers to trip under sustained overload.

c. Adjustable short time pickup:
    1) Controls the level of high current the breaker will carry for short periods.
d. Adjustable short time delay:
    1) Controls the length of time the breaker will carry a high current without tripping.
e. Adjustable instantaneous pickup:
    1) Controls level at which immediate tripping of breaker occurs.
f. Adjustable ground fault pickup:
    1) Controls the level at which the breaker will trip under a ground fault condition.
g. Adjustable ground fault delay:
    1) Controls the time that a ground fault can exist without tripping the breaker.
h. Long time pickup indicator:
    1) Provides a visual indication that the breaker is experiencing an overload condition.
i. Energy reducing maintenance switch:
    1) Allows for input of alternative trip settings for arc flash hazard reduction during maintenance procedures.
    2) Enabled by the following:
        a) Hardwired input.
        b) Trip unit controls.
        c) Trip unit network.
    3) Status:
        a) Contact for remote indication.
        b) Indication on trip unit.
        c) Status communicated over trip unit network.

D. Fault indicators:
    1. Powered from a lithium battery.
    2. LED indicators for:
        a. Overcurrent fault trip on long-time feature.
        b. Overcurrent fault trip on short-time feature.
        c. Short circuit fault trip on the instantaneous feature.
        d. Ground fault trip.

## 2.08 ACCESSORIES

A. Provide circuit breakers with the following accessories as indicated on the Drawings and required for proper operation of the system:
    1. Operations counter.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES (NOT USED)

## 2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
    1. UL 489.

2. Manufacturer's standard testing procedures.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. Install breakers to correspond to the accepted Shop Drawings.

### 3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

### 3.05 OWNER TRAINING

A. Not required.

### 3.06 ADJUSTING

A. Adjust trip settings in accordance with the Protective Device Coordination Study as accepted by the Engineer and in accordance with the manufacturer's recommendations.

END OF SECTION

## SECTION 16422

## MOTOR STARTERS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Motor starters and contactors.

### 1.02 REFERENCES

A. Abbreviations:
   1. FVNR: Full voltage non-reversing.

B. Standards:
   1. Institute of Electrical and Electronics Engineers (IEEE).
   2. International Electrotechnical Commission (IEC):
      a. 801-1 - Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment - Part 1: General Information.
      b. 947-4 - Low-Voltage Switchgear and Control Gear.
   3. National Electrical Manufacturer’s Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
      b. ICS 2-230 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V.
   4. Underwriters Laboratories, Inc. (UL):
      a. 508 - Standard for Industrial Control Equipment.
      b. 508A - Standard for Industrial Control Panels.

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Overload relay class: A classification of an overload relay time current characteristic by means of a number which designates the maximum time in seconds at which it will operate when carrying a current equal to 600 percent of its current rating.

### 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

### 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures:
   1. Submit motor starter data with equipment submittal.

B. Product data:
   1. Manufacturer.
   2. Catalog cutsheets.
   3. Technical information.
   4. Complete nameplate schedule.
   5. Complete bill of material.
   6. List of recommended spare parts.
   7. Confirmation that the overload relay class for each starter meets the requirements of the equipment and motor supplier.
   8. Electrical ratings:
      a. Phase.
      b. Wire.
      c. Voltage.
      d. Ampacity.
      e. Horsepower.
   9. Furnish circuit breaker submittals as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

C. Shop Drawings:
   1. Elementary and schematic diagrams:
      a. Provide 1 diagram for every starter and contactor.
      b. Indicate wire numbers for control wires on the diagrams:
         1) Wire numbering as specified in Section 16075 - Identification for Electrical Systems.
      c. Indicate interfaces with other equipment on the Drawings.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.
      c. For wall mounted equipment weighing 125 pounds or more.

E. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Manufacturer’s representative qualifications.
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer’s representatives field notes and data.
      f. Owner Training.

F. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.

2. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment furnished or installed under this Section, including, but not limited to:
   a. Electrical ratings:
      1) Phase.
      2) Wire.
      3) Voltage.
      4) Ampacity.
   b. Complete bill of material.
   c. Manufacturer's operating and maintenance instructions starter and/or contactor component parts, including:
      1) Protective devices (fuses, breakers, overload relays, heater elements, etc.).
      2) Pilot devices.
   d. Complete renewal parts list.
   e. As-built drawings:
      1) Furnish as-built drawings for each starter and contactor indicating final:
         a) Wire numbers.
         b) Interfaces with other equipment.
      2) 11-inch by 17-inch format.

G. Certifications:
1. Provide manufacturer's certification that the reduced voltage solid state starter will reliably control the acceleration and deceleration of the driven load at the installed conditions.
   a. Failure of the manufacturer to provide said certification will be interpreted to mean that the manufacturer has agreed that the reduced voltage solid state starter is matched to the driven load at the installed conditions and will function without fault.
   b. If the reduced voltage solid-state starter fails to perform as desired, replace or modify the reduced voltage solid-state starter in order to achieve the desired operational conditions, as directed by the Engineer.

## 1.06 QUALITY ASSURANCE

A. Regulatory requirements:
1. Starters and components shall be UL listed and labeled:
   a. UL 508 - Industrial Control Equipment.
   b. UL 508A - Industrial Control Panels.
2. NEMA ICS 2 - Industrial Control and System Controllers; Contactors and Overload Relays Rated: 600 Volts.
3. Combination starters shall be UL listed and labeled.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Reduced voltage solid state starters:
   1. Submit certification that the RVSS will reliably accelerate and decelerate the driven load at the installed conditions as part of the equipment submittal.
   2. RVSS start-up and testing by manufacturer after connection to equipment.
   3. RVSS training by manufacturer after start-up and testing, and before plant commissioning.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

## 1.11 MAINTENANCE

A. Spare parts:
   1. Provide the following spare parts, suitably packaged and labeled with the corresponding equipment number:
      a. 1 spare fuse of each size and type per starter.
      b. 1 of each type of circuit board used in the RVSS starters, including, but not limited to:
         1) Control board.
         2) Power board.
         3) Bridge rectifier.
         4) Inverter module.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Starters for motor control centers, individual enclosed starters, or control panels.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. For equipment located in non-conditioned spaces, provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer's specified operating ranges.

## 2.03 MANUFACTURERS

A. One of the following or equal:
  1. NEMA starters and contactors:
    a. ABB.
    b. Allen-Bradley.
    c. Eaton.
    d. Schneider Electric.
  2. Reduced voltage solid state starters:
    a. ABB.
    b. Allen-Bradley.
    c. Benshaw.
    d. Eaton.
    e. Schneider Electric.
  3. Manual motor starters:
    a. ABB.
    b. Cutler-Hammer.
    c. Schneider Electric.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS

A. General:
  1. Provide combination type starters with motor circuit protector or thermal-magnetic circuit breaker and control power transformer with ratings as indicated on the Drawings.
  2. NEMA size, design, and rated:
    a. NEMA Size 1 minimum.
  3. Coordinate motor circuit protector, thermal magnetic circuit breaker, or fusible disconnect, and overload trip ratings with nameplate horsepower and current ratings of the installed motor.
    a. If motors provided are different in horsepower rating than those specified or indicated on the Drawings, provide starters coordinated to the actual motors furnished.
  4. Provide starters NEMA Size 2 and larger with arc quenchers on load breaking contacts.
  5. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.

B. Full voltage starters (FVNR):
  1. Across-the-line full voltage magnetic starters.
  2. Rated for 600 volts.
  3. Electrical characteristics as indicated on the Drawings.
  4. Provide positive, quick-make, quick-break mechanisms, pad lockable enclosure doors.
  5. Furnish starter with bi-metallic overload relays.
  6. Double-break silver alloy contacts.

C. RVSS:
1. Manufactured and tested in accordance with the applicable requirements of IEEE, UL, and NEMA, including the following:
    a. Dielectric withstand in accordance with UL 508.
    b. Noise and RF immunity in accordance with NEMA ICS-2.
2. Furnish with a motor circuit protector or thermal magnetic circuit breaker as indicated on the Drawings.
3. Provide protection against internal faults and high SCR temperature during operation of the motor including starting, running (except when bypassed), and stopping modes.
4. Capable of continuously delivering full rated current of the motor plus the motor service factor in ambient temperatures from 0 degrees Celsius to 40 degrees Celsius at the installed altitude.
5. Provide a magnetically operated bypass contactor in parallel with the solid state starter:
    a. Bypass contactor to energize when the motor has reached full speed:
        1) Electronic overload protection circuits must be fully functional with the bypass contactor closed.
6. RVSS control module requirements:
    a. Microcomputer based and contains the required circuitry to drive the power semiconductors in the power section of the starter.
    b. Integrally mounted on the power section and requires no additional panel space or wiring.
    c. Mounted for easy wiring, testing, service, and replacement.
    d. Provide 3-phase current sensing.
    e. Quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs, and SCR gate firing output circuits.
    f. Operates on power supplied from a control power transformer.
    g. Phase insensitive or with phase rotation protection.
    h. Control modes:
        1) Soft start with adjustable linear ramp time and a “kick start” or “boost” feature to provide a short time (typically 0.1 seconds) application of approximately full voltage.
        2) Soft start with adjustable linear ramp time, with a current limit:
            a) Current limit shall be adjustable over the range of 2 to 4 times normal full load current.
        3) Reverse voltage ramp (line voltage to zero voltage):
            a) Adjustable from 2 to 30 seconds to provide smooth stop.
            b) Automatic shutdown at end of voltage ramp.
    i. Protective functions:
        1) Single phase protection.
        2) Under voltage protection.
        3) Short circuit electronic trip overcurrent protection. Time not to exceed 3 cycles.
        4) Inverse time running overcurrent protection.
        5) Auxiliary trip circuitry.
        6) Gate firing circuit lockout protection on trip.
        7) Jam and stall detection.
        8) Fault relay lockout protection.
        9) 100 percent to 130 percent full load running current trip adjustment.
        10) 100 percent to 450 percent of starting current limit adjustment.

11) Dwell time at current limit with ramp continuation after acceleration.
12) Individual light emitting diodes (LEDs) for trip and phase loss.
13) Minimum and maximum initial starting voltage adjustments.
14) Initial torque adjustment.

7. RVSS power section requirements:
   a. 3 sets of back-to-back phase-controlled power semiconductors:
      1) Minimum repetitive peak inverse voltage of 1,500 volts at 480 VAC.
      2) Resistor/capacitor snubber networks to prevent false firing of the SCRs.
      3) Equipped with individual heat sink assemblies.
      4) Provide high-speed fuses for protection of the SCR stacks against short circuit conditions.
   b. Provide metal oxide varistors for surge protection on the line and load side power terminal connections:
      1) Rated for a minimum of 120 joules.
   c. Capable of supplying the following current levels:
      1) 600 percent of full load current for a minimum of 10 seconds.
      2) 450 percent of full load for a minimum of 30 seconds.
   d. Furnish ground lugs, 1 for incoming and 1 for outgoing ground connections.
   e. Furnish pressure type terminals for top or bottom entry power terminations.
8. Remote indicators:
   a. Provide Form C dry contacts for remote indication of:
      1) Internal fault error.
      2) Undervoltage.
      3) Overvoltage.
      4) Phase reversal.
      5) Phase loss.
      6) Overload.
      7) Frequency out of range.
      8) Excessive starts per hour.
      9) Drive electronics over temperature.
      10) Stall.
      11) Jam.
      12) System failure.
      13) Starter failure.
      14) Run status.
      15) Full speed.

D. Manual motor starters:
1. General:
   a. Provide with number of poles as indicated on the Drawings or as required by the connected load.
   b. Provide handles that clearly indicate the On and Off (with lockout), positions.
   c. Switch shall have positive, quick-make, quick-break mechanisms.
2. Thermal overload switches:
   a. Provide thermal overloads in manual motor starters where integral overloads are not furnished with the motor.

b. Size heater elements for approximately 115 percent of the nameplate full load current, for motors with a 1.15 service factor.
c. Thermal overload units in all phase legs.
d. Overload conditions interrupts ungrounded conductors.

3. Enclosure:
   a. Provide the NEMA enclosure type specified in Section 16050 - Common Work Results for Electrical for the starter location.

## 2.06 EQUIPMENT (NOT USED)

## 2.07 COMPONENTS

A. Molded case circuit breakers:
   1. Circuit breaker type and ratings as indicated on the Drawings.
   2. Provide as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

B. Contactors:
   1. NEMA size as indicated on the Drawings.
   2. Electrically held:
      a. For lighting loads designed to withstand the initial inrush currents of ballast and lamp loads.
   3. Factory adjusted and chatter free.
   4. Auxiliary contacts:
      a. Contact ratings in accordance with NEMA A600 rating:
         1) Auxiliary contacts rated 10 amps at 600 volts.
      b. Provide contacts indicated on the Drawings and any additional contacts required for proper operation.
      c. Provide at least 1 normally open and 1 normally closed spare auxiliary contact.
   5. Constructed in accordance with the following standards:
      a. UL 508.
      b. IEC 947-4:
         1) Type 1 coordination when protected by a circuit breaker.
         2) Type 2 coordination when protected by a suitable UL listed fuse.
      c. IEC 801-1 parts 2 through 6.

C. Overloads:
   1. Bi-metallic overload relay:
      a. Class 20 protection.
      b. Ambient compensated.
      c. Interchangeable heater pack:
         1) 1 heater per phase.
         2) Coordinate with installed motor full load amps and service factor.
      d. Visible trip indicator.
      e. Push-to-trip test.
      f. Isolated normally open alarm contact.
      g. Normally closed trip contacts.
      h. Manual reset.

D. Control power transformer:
   1. Furnish integral control power transformer capacity to power:
      a. Motor controls: Motor and starter accessories indicated on the Drawings or specified.
   2. Primary and secondary fusing as indicated on the Drawings:
      a. Fusing sized by the manufacturer for the rating of the transformer furnished.
   3. Control power transformer secondary voltage:
      a. As indicated on the Drawings.

## 2.08 ACCESSORIES

A. Lugs and terminals:
   1. For external connections of No. 6 AWG and larger.
   2. UL listed for either copper or aluminum conductors.

B. Surge protective devices:
   1. Furnish surge protection devices across the coil of each starter, contactor, and relay.

C. Pilot devices:
   1. Provide pilot lights, switches, elapsed time meters, and other devices as specified or as indicated on the Drawings.
   2. As specified in Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

D. Nameplates and wire markers:
   1. As specified in Section 16075 - Identification for Electrical Systems.

E. Conformal coating:
   1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as $H_2S$ and chlorine.

F. Current switch:
   1. Provide current switches where indicated on the Drawings for monitoring of motor currents.
   2. Solid or split core current transformer.
   3. Self-powered from monitored conductor.
   4. Adjustable setpoint.
   5. LED indicators for setup and status.
   6. Normally open contact.
   7. Select the range based on the amperage of the driven equipment.
   8. Manufacturers: One of the following or equal:
      a. Eaton CurrentWatch.
      b. Veris, Hawkeye X09 Series.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES (NOT USED)

## 2.11 SOURCE QUALITY CONTROL

A. RVSS starters:
   1. Manufacturer of the respective RVSS starter shall supply certified test results to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA standards.
   2. Tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting, rigidity, and bus bracing. In addition, the unit shall be factory tested in accordance with ANSI standards.
   3. RVSS starter manufacturer shall test for noise immunity on both input and output power connections and provide test results to the Engineer. Noise testing shall be performed in accordance with NEMA ICS 2.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Starters in motor control centers:
   1. Install as specified in Section 16444 - Low Voltage Motor Control Centers.

C. Starters in control panels:
   1. Install as specified in Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

D. Manual motor starters:
   1. Provide complete mounting brackets and hardware as necessary for complete support of manual motor starter at locations indicated on the Drawings.
   2. Mount manual motor starter rigidly to exposed building or equipment structural members.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Not witnessed.

2. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Owner Training:
   1. Not required.

## 3.05 FIELD QUALITY CONTROL

A. RVSS:
   1. Provide the services of the manufacturer's technical representative for start-up, adjustment, and troubleshooting, for each starter at the Owner's facility.

## 3.06 ADJUSTING

A. Make adjustments as necessary and as recommended by the manufacturer, Engineer, or testing firm.

B. Set overloads and motor circuit protectors based on the nameplate values of the installed motor.

END OF SECTION

## SECTION 16442

## INDIVIDUALLY MOUNTED CIRCUIT BREAKER SWITCHBOARDS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Free standing, dead-front type metal-enclosed, low voltage switchboards with individually mounted circuit protective devices.

### 1.02 REFERENCES

A. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. PB 2 - Deadfront Distribution Switchboards.

C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code.
   2. 70E® - Standard for Electrical Safety in the Workplace®.

D. Underwriters Laboratories, Inc. (UL):
   1. 891 - Switchboards.

### 1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of switchboard.
   2. Manufacturer of component parts of switchboard.
   3. Dimensions:
      a. Width.
      b. Length.
      c. Height.
      d. Weight.
   4. Nameplate schedule.
   5. Bill of material.
      a. Automatic transfer system as specified in Section 16491 - Transfer Switches.

6. Ratings:
   a. Voltage.
   b. Phase.
   c. Current.
   d. Interrupting rating (circuit breakers and fuses).
7. List of recommended spare parts.
8. Name of dealer’s repair facility and parts stocking agreement with the factory:
   a. Agreement shall outline in detail the manufacturer’s parts stocking requirements and the method by which the manufacturer’s representative verifies that the stock is at an acceptable level.
   b. Agreement should also outline the method by which the manufacturer’s representative determines that the service personnel meet factory standards.
   c. A toll-free or local phone number with 24/7 emergency monitoring/call back is required.
9. Furnish circuit breaker Submittals as specified in:
   a. Section 16412 - Low Voltage Molded Case Circuit Breakers.
   b. Section 16413 - Low Voltage Insulated Case Circuit Breakers.
10. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
   a. Manufacturer’s statement of seismic qualification with substantiating test data.
   b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
1. Complete, detailed, and scaled switchboard layout:
   a. Front panel.
   b. Sub-panels.
   c. Interior panels.
   d. Top and bottom conduit windows.
2. Complete electrical wiring diagrams:
   a. Point-to-point connections.
   b. Internal compartment-to-compartment interconnection wiring diagrams.
   c. Wiring identification and terminal numbers.
3. Complete 3-line diagrams for each switchboard lineup.
   a. These Drawings shall indicate devices comprising the switchboard assembly, including, but not limited to, circuit breakers, control power and instrument transformers, meters, and control devices.
   b. Clearly indicate electrical ratings of devices on Drawings.
4. Complete interface and connection diagrams for metering system.
5. Complete bill of material list and equipment datasheets identifying appropriate information specific to the switchboard being supplied.
6. Nameplate schedule.
7. Interfaces to other equipment.
   a. Detail of interface connections to automatic transfer breakers, engine generators, etc.

D. Calculations:
1. DC power and current requirements needed to operate the switchboard circuit breakers and automatic transfer equipment.

E. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.

F. Installation instructions:
   1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   3. Manufacturer's Certificate of Installation Verification as specified in Section 01756 - Commissioning.
   4. Test reports.

H. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

I. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Operating instructions:
      a. Printed and framed instruction chart suitable for wall hanging.
      b. Detail the operational functions custom controls which have been placed on the front of the switchboard.
   3. Maintenance manual:
      a. Furnish maintenance manuals with instructions for maintenance of equipment and data identifying all parts.
      b. Include information needed to maintain the switchboard, including, but not limited to, the following:
         1) Instructions for testing, adjustment, and start-up.
         2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
         3) Description of the sequence of operation, which outlines the steps the switchboard follows during normal power failure, fault conditions, and return of normal power.
         4) Schematic and wiring diagrams:
            a) Showing internal and external connections.
            b) Furnished in a reduced 11-inch by 17-inch fully legible format.

## 1.05 QUALITY ASSURANCE

A. Switchboard and components shall be UL listed and labeled.

B. Equipment shall be designed and constructed in accordance with the following standards and requirements:
   1. NEMA PB 2.
   2. UL 891.

C. Manufacturer shall be ISO 9001 certified.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship switchboards to the Site in dedicated air ride vans that will allow the Contractor to utilize on-site off-loading equipment.

B. Furnish temporary equipment heaters within the switchboard to prevent condensation from forming.

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for the Engineer’s review.
   2. After successful review of the initial fault current study, submit complete equipment Submittal.
   3. Conduct factory acceptance test and submit certified test results for the Engineer’s review.
   4. Ship equipment to the Project Site after successful completion of the factory acceptance test.
   5. Assemble equipment in the field.
   6. Conduct final fault current and coordination study.
   7. Conduct field acceptance test and submit results for the Engineer’s review.
   8. Submit manufacturer’s certification that the equipment has been properly installed and is fully functional for the Engineer’s review.
   9. Conduct Owner Training sessions.
   10. Commissioning as specified in Section 01756 - Commissioning.

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Factory assembled, wired, and tested switchboards, with major components being products of a single manufacturer, including circuit breakers, and other equipment specified in this Section and indicated on the Drawings.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
  1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
  1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

D. Provide complete and functional switchboards with required controls.

E. Furnish and install devices or accessories not described in this Section but necessary for the proper installation and operation of the equipment.

## 2.03 MANUFACTURERS

A. One of the following or equal:
  1. ABB.
  2. Eaton.
  3. Schneider Electric.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Voltage ratings:
  1. Voltage level and configuration: As indicated on the Drawings.
  2. Frequency: 60 hertz.
  3. Insulation level:
    a. Twice the rated voltage plus 1,000 volts.

B. Bus:
  1. General:
    a. Tin-plated copper.
    b. Bus cross-section in accordance with UL heat rise requirements.
    c. Current density of 1,000 amps per square inch.
    d. Mounted on supports of high-impact, non-tracking insulators.
    e. Phase A-B-C bus arrangement:
      1) Top-to-bottom, left-to-right, front-to-back throughout the switchboard.
    f. Symmetrical short circuit current bracing of as indicated on the Drawings.
    g. Continuous current rating as indicated on the Drawings.

2. Horizontal bus:
    a. Provisions for future connections to additional switchboard sections.
3. Ground bus:

C. Sized in accordance with UL 891.Space for future devices:
    1. Provide spaces as indicated on the Drawings.
    2. As specified in Section 16050 - Common Work Requirements for Electrical.

D. Enclosure:
    1. General:
        a. Self-supporting structures bolted together to form the required line-up.
        b. All sections rear aligned.
        c. Dead-front.
        d. Conduit entry:
            1) Open bottom.
            2) Removable top cover.
    2. Frame:
        a. Die-formed 12-gauge steel.
    3. Covers:
        a. Bolt-on.
        b. Code gauge steel.
        c. Removable front covers:
            1) Held in place by captive screws.
    4. Rating:
        a. NEMA Type 3R:
            1) Sloped roof.
            2) Filtered vents to provide ventilation to maintain the equipment within its operating temperature range.
            3) Space heaters to prevent condensation.
            4) Control power transformer:
                a) Sized to power space heaters, lights, and receptacles.
                b) Primary and secondary fusing.
            5) Doors:
                a) Front and rear.
                b) Wind stop on each door.
                c) 3-point catch with provision for padlock.
                d) Front to rear full depth lifting beams.
            6) Gasketed.
            7) LED light.
            8) 120-volt, 15-amp GFCI convenience outlet.
            9) Non walk-in construction.

## 2.07 COMPONENTS

A. Circuit breakers:
    1. As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers and Section 16413 - Low Voltage Insulated Case Circuit Breakers.
    2. Individually mounted with line and load bus connections.

3. Main circuit breakers shall be 100 percent rated, drawout mounted insulated case breaker with frame and trip ratings as indicated on the Drawings.
   a. Breaker with rating of 1,000 amps or more shall be provided with ground fault shunt trip.
4. Individually fixed mounted feeder devices shall be insulated case circuit breaker with ratings as indicated on the Drawings.
5. Have a minimum interrupting rating equal to the bus rating or as indicated on the Drawings.

B. Wiring:
1. Provide necessary internal wiring, fuse blocks, and terminal blocks as required. Number wires at each end and indicate wire numbers on Shop Drawings.
2. Type SIS switchboard wire with at least 26 strands.
3. Minimum wire size:
   a. No. 14 for control circuits.
   b. No. 12 for voltage and current transformer circuits.
4. Numbered and labeled as specified in Section 16075 - Identification for Electrical Systems.

C. Control power transformers:
1. Provide 480- to 120-volt control power transformers as indicated on the Drawings.
2. Control power transformers to have capacity for 125 percent of the load served.
3. Protect control power transformers with both primary and secondary fuses. Protect primary side with current limiting fuses.

## 2.08 ACCESSORIES

A. Metering system:
1. Provide power meters as indicated on the Drawings.
2. As specified in Section 16290 - Electrical Power Monitoring.

B. Surge protective devices:
1. As specified in Section 16285 - Surge Protective Devices.

C. Nameplates:
1. As specified in Section 16075 - Identification for Electrical Systems.
2. Furnish an individual nameplate for each breaker and/or switch identifying the load served.
3. Furnish an individual nameplate for each vertical section identifying the vertical section:
   a. Mounted and centered on the top horizontal wireway for each vertical section.
4. Furnish an individual nameplate for each cubicle:
   a. 1 nameplate to identify cubicle designation.
   b. 1 nameplate to identify load served.
5. Manufacturer’s labels:
   a. Each vertical section shall have a label identifying:
      1) Serial number.
      2) Shop order number.

        3) Bus rating.
        4) Vertical section reference number.
        5) Date of manufacture.

D. Warning signs:
   1. Voltage:
      a. Provide a minimum of 2 warning signs on the front of the switchboard lineup and 2 on the back.
      b. Red laminated plastic engraved with white letters approximately 1/2-inch high.
      c. Signs shall read:
         1) “WARNING-HIGH VOLTAGE-KEEP OUT”.
   2. Arc flash:
      a. Provide 1 warning sign for each switchboard compartment.
      b. Signs shall have read a minimum of:
         1) “DANGER ELECTRIC ARC FLASH HAZARD.”
         2) Signs shall meet the requirements of NFPA 70E and NEC Article 110.16.

E. Automatic transfer system:
   1. As specified in Section 16491 - Transfer Switches.

F. Space heaters:
   1. Fused, thermostatically controlled, strip-type, operated at half voltage for long life:
      a. 500-volt or 250-volt rated heaters at 240 volt or 120 volt, respectively.
   2. Powered from the switchboard control power transformer from 120/240 remote power source.
   3. Each powered through its own dedicated circuit breaker.

G. Lugs:
   1. For external connections of No. 6 AWG or larger, plated or otherwise suitable for copper or aluminum and UL listed for copper or aluminum.
   2. Shall be of the compression type in design requiring a hydraulic press and die for installation as manufactured by:
      a. Burndy.
      b. T&B.

H. Key interlocks:
   1. Provide key interlocks as indicated on the Drawings.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES

A. Chemically clean steel surfaces before painting.

B. Exterior color manufacturer’s standard gray over phosphate-type rust inhibitor.

## 2.11 SOURCE QUALITY CONTROL

A. Source Testing:
   1. Not witnessed.
   2. Test in accordance with manufacturer's standard testing procedures.
   3. Furnish test reports and Manufacturer's Certificate of Source Testing.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories needed to complete the installation of the switchboard.
   2. Physically assemble and install the switchboard in the location and layout indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform Work in accordance with the manufacturer's instructions and Shop Drawings.
   5. Furnish components and equipment as required to complete the installation.
   6. Replace hardware lost or damaged during the installation or handling to provide a complete installation.
   7. Install the switchboard on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
      b. Weld and/or bolt the switchgear frame to the leveling channels.
   8. Provide openings in top or bottom of the enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.

C. Furnish Manufacturer's Certificate of Installation Verification.

## 3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

C. Provide the services of a qualified manufacturer's representative to:
   1. Inspect, verify, and certify that the mechanical installation meets the manufacturer's requirements.
   2. Make control connections across the shipping splits.
   3. Install and align circuit breakers.
   4. Make bus splice connections.
   5. Make control connections across shipping splits.
   6. Ensure that items furnished are in proper operating condition:
      a. Technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.

## 3.05 OWNER TRAINING

A. Not required.

## 3.06 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

END OF SECTION

## SECTION 16444

## LOW VOLTAGE MOTOR CONTROL CENTERS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Low voltage motor control centers.

### 1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. ICS 18-2001 - Motor Control Centers.

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Underwriters Laboratories (UL):
   1. 845 - Motor Control Centers.

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. SELV: Safety extra-low voltage.

### 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

### 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of motor control center.
   2. Manufacturer of motor control center parts.
   3. Nameplate schedule.
   4. Bill of material.
   5. Enclosure:
      a. NEMA rating.
      b. Finish color.
   6. Ratings:
      a. Voltage.
      b. Phase.

c. Current:
   1) Horizontal bus ampacity.
   2) Vertical bus ampacity.
   3) Ground bus ampacity.
d. Short circuit withstand rating.
e. Protective device interrupting rating.

7. List of recommended spare parts.
8. Catalog cutsheets:
   a. Submit complete manufacturer's catalog information:
      1) Clearly indicate the features of the equipment including any options necessary to meet the required functionality.
9. Furnish component Submittals as specified in the appropriate Section.
10. For equipment installed in structures designated as seismic design category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Layout drawings:
   a. Provide fully dimensioned and to scale layout drawings which include:
      1) Dimensions:
         a) Overall length.
         b) Overall width.
         c) Overall height.
         d) Overall weight and weight of individual shipping splits.
2. Interfaces to other equipment.
3. Shipping splits.
4. Allowable top and bottom conduit windows.
5. Complete component and unit layout drawings, including control, networking, and metering components.
6. Indicate lug sizes, type, and manufacturer based on the cable size specified in the Contract Documents and as indicated on the Drawings.
7. Elementary schematics:
   a. Provide 1 custom schematic diagram for each compartment:
      1) Include remote devices.
      2) Show wire numbers on the schematics:
         a) Provide wire numbering as specified in Section 16075 - Identification for Electrical Systems.
8. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
9. One-line diagrams:
   a. Provide complete one-line diagrams for each motor control center, including, but not limited to: Protective devices, starters, drives, metering, and other equipment.
   b. Indicate electrical ratings of the equipment shown on the one-line diagrams.

D. Delegated Design Submittals:
   1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
      a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
      b. For equipment installed outdoors.

E. Installation instructions:
   1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
   2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
   1. As specified in Section 01756 - Commissioning, including the following:
      a. Manufacturer's representative qualifications.
      b. Certificates:
         1) Requirements as specified in this Section.
      c. Test Plans:
         1) Test requirements as specified in this Section.
      d. Test Reports.
      e. Manufacturer's representatives field notes and data.
      f. Owner Training.

G. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Provide complete operating and maintenance instructions presenting full details for care and maintenance of all types of equipment furnished and/or installed under this Section. Include the following:
      a. Electrical ratings:
         1) Phase.
         2) Wire.
         3) Voltage.
         4) Ampacity.
         5) Bus bracing and protective device interrupting ratings.
      b. Manufacturer's operating and maintenance instructions for the motor control center and component parts, including:
         1) Starters.
         2) Overload relays and heater elements.
         3) Variable frequency drives.
         4) Protective devices, including, but not limited to, fuses, circuit breakers and protective relays.
         5) Pilot devices.
      c. Complete renewal parts list.

H. Test forms and reports:
   1. Submit complete factory acceptance test procedures and forms used during the test.

I. Record documents:
   1. Elementary schematics:
      a. Furnish as-built elementary schematics indicating final:
         1) Wire numbers.
         2) Interfaces with other equipment.
      b. Provide 1 custom schematic diagram for each compartment:
         1) Include remote devices.
         2) Show wire numbers on the schematics.
      c. Layout drawings: Provide complete dimensioned component and unit layout drawings.
   2. Record documents shall reflect modifications made during the submittal review process and during construction.

J. Calculations:
   1. Detailed calculations or details of the actual physical testing performed on the motor control center to prove the motor control center is suitable for the seismic requirements at the Project Site.

## 1.06 QUALITY ASSURANCE

A. All portions of the motor control center, vertical bays, and components shall be UL listed and labeled.
   1. Where indicated as service entrance equipment, the motor control center shall be UL labeled and listed “Suitable for Service Entrance”.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the motor control center and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment.

B. Furnish temporary equipment heaters within the motor control center to prevent condensation from forming.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for Engineer’s review.
   2. After successful review of the initial fault current study, as specified in Section 16305 - Electrical System Studies, submit complete equipment submittal.
   3. Conduct factory acceptance test.
   4. Submit manufacturer’s test results.
   5. Ship equipment to the Project Site after successful completion of factory acceptance test.
   6. Assemble equipment in the field.
   7. Conduct field acceptance test and submit results for Engineer’s review.

8. Submit manufacturer’s certification that the equipment has been properly installed and is fully functional for Engineer’s review.
9. Conduct Owner’s training sessions.
10. Commissioning and process start-up as specified in Section 01756 - Commissioning.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Factory assembled, factory wired and factory tested motor control centers:
   1. Motor control centers and major components to be products of a single manufacturer.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Existing motor control centers:
   1. Provide complete motor control center vertical sections or individual motor control center units to be added to existing motor control centers as specified in this Section and as indicated on the Drawings.
   2. Provide additions that are of the same manufacturer, type, and electrical ratings as the existing motor control centers:
      a. Provide hardware necessary to connect the busses of the new and existing motor control centers.
   3. Provide enclosures to match the NEMA ratings and colors of the existing motor control centers.

## 2.03 MANUFACTURERS

A. One of the following, or equal:
   1. ABB.
   2. Allen-Bradley.
   3. Eaton.
   4. Schneider Electric.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. General:
   1. Furnish motor control centers as specified in the Contract Documents and indicated on the Drawings.
   2. Arrange the equipped sections to form continuous motor control center lineups as indicated on the Drawings:
      a. Identify any deviations from the Drawings in writing and submit for approval.
   3. Provide wire markers at each end of every wire as specified in Section 16075 - Identification for Electrical Systems.
   4. Provide complete and functional motor control centers.
   5. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

B. Design and construct motor control center to operate at the voltage level and configuration indicated on the Drawings.

C. Bus system:
   1. Material:
      a. Tin-plated copper.
      b. Short-circuit rating:
         1) As indicated on the Drawings.
      c. Bus bar supports:
         1) High impact strength, non-tracking glass-polyester material that is impervious to moisture and gases.
   2. Horizontal power bus:
      a. Current-carrying capacity as indicated on the Drawings.
      b. Mounting:
         1) Mount horizontal bus bars edgewise, one above the other, and fully isolated from wireways and units.
      c. Temperature rise:
         1) In accordance with UL 845.
         2) De-rate the temperature rating of the bus for the specified conditions of ambient temperature and altitude as specified in Section 01850 - Design Criteria.
   3. Vertical power bus:
      a. Current-carrying capacity of not less than 600 amps.
      b. Mounting:
         1) Enclose the vertical bus in a polyester-glass cover with small openings to permit unit stabs to mate with the bus:
            a) Provide a shutter mechanism to cover the stab openings when plug-in units are removed.
         2) Provide top and bottom bus covers for insulation and isolation of the ends of the bus.
      c. Isolated from the unit compartments by a full height barrier.
   4. Ground bus:
      a. Horizontal ground bus:
         1) Current-carrying capacity:
            a) 300 amps when the horizontal bus is 2,000 amps or less.
            b) 600 amps when the horizontal bus is greater than 2,000 amps.

2) Mounting:
  a) Full width, firmly secured to each vertical section structure:
    (1) Located in the top or bottom wireway.
  b) Pre-drilled and furnished with lugs for connection to equipment ground wires:
    (1) Furnish a minimum of 10 lugs per vertical section of MCC.

b. Vertical ground bus:
  1) Mounting:
    a) Furnish in each vertical section.
    b) Bolted to the horizontal ground bus.
    c) Install parallel to the vertical power bus.
    d) Mount vertical ground bus such that plug-in units engage the ground bus before any connection to the power bus is made. Upon removal of plug-in units, ground stabs are disconnected from the ground bus after the power stabs have been disconnected.

5. Bus splice bars:
  a. Provided to join the bus at the splits.
  b. Connected to each horizontal bus bar with a minimum of 2 bolts.
  c. Employ conical or spring washers at connections, designed to maintain constant pressure against the splice joint.
  d. Same ampacity rating as the horizontal bus.
6. Provide bus system configured for back-to-back MCCs, where required.

D. Enclosures:
  1. Each motor control center shall consist of 1 or more vertical sections bolted together:
    a. Freestanding.
    b. Totally enclosed.
    c. Dead-front assembly.
    d. Designed for modification and/or addition of future vertical sections.
    e. Form each vertical section of heavy gauge steel.
    f. Designed for back-to-back arrangement installation, where required and/or as indicated on the Drawings.
  2. Enclosure rating:
    a. Indoor:
      1) NEMA Type 1 gasketed.
  3. Standard section dimensions:
    a. Nominal height: 90 inches.
    b. Nominal depth: 20 inches.
    c. Vertical section width as indicated on the Drawings.
  4. Wireways:
    a. Provide each vertical section with a horizontal wireway at the top and bottom of the section:
      1) Arranged to provide a full-width metal enclosed wiring trough across the entire motor control center assembly.
    b. Provide each vertical section with a full-height vertical wireway.
    c. Completely isolated from the vertical and horizontal bus bars.
    d. Provide a removable, hinged door.
  5. Shipping splits:
    a. No more than 3 vertical sections and not more than 60 inches in width.

b. Solid bussing between vertical sections in a shipping split is not acceptable.
6. Lifting angles:
    a. Furnish each vertical section and/or shipping split with a removable lifting angle mounted to the top of the enclosure:
        1) Extending the entire width of the shipping split.
7. Mounting channels:
    a. Mount each vertical section and/or shipping split on an external 1.5-inch by 3-inch mounting channel.

E. Units:
1. A plug-in unit consists of:
    a. Assembly.
    b. Support pan.
    c. Door assembly.
2. Completely enclosed and isolated from adjacent units, buses, and wireways, except for conductor entries into the unit, by a metal enclosure.
3. Supported and guided by a removable unit support pan:
    a. Re-arrangement of units and the removal of a unit so that a new and possibly larger unit can be added without the removal of an in-service unit to gain access to the unit support pan.
4. Held in place by screws or other positive locking means after insertion.
5. Provide a test position with the unit supported in the structure but disengaged from the bus.
6. Integral plug-in ground stab.
7. Stabs:
    a. Free floating.
    b. Self-aligning.
    c. Backed by spring steel clips to ensure high pressure contacts.
    d. Electrolytically tin-plated copper.
8. Handle:
    a. Provide a flange mounted handle mechanism to operate each disconnect switch or circuit breaker.
    b. Door mounted operators or operator handles are not acceptable.
    c. Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.
    d. Lockable in the “OFF” position with up to 3 padlocks.
    e. Mechanically interlocked so that the door cannot be opened with the handle in the “ON” position:
        1) Provide a means for qualified personnel to defeat this interlock.
    f. Interlocked so the unit cannot be inserted or withdrawn with the handle in the “ON” position.
    g. Lockable in the “ON” position:
        1) This shall not prevent the circuit breaker from operating and opening the contacts in the event of a fault condition.
    h. Color-coded to indicate position.
    i. Located so the center of the grip when it is in its highest position is not more than 6 feet 7 inches above the finished floor, including the height of the housekeeping pad and mounting channels.
9. Space for future devices:
    a. Provide spaces as indicated on the Drawings.

b. As specified in Section 16050 - Common Work Requirements for Electrical.

## 2.07 COMPONENTS

A. Provide components contained within the motor control center as specified in:
1. Section 16075 - Identification for Electrical Systems.
2. Section 16123 - 600-Volt or Less Wires and Cables.
3. Section 16150 - Low Voltage Wire Connections.
4. Section 16290 - Electrical Power Monitoring.
5. Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.
6. Section 16285 - Surge Protective Devices.
7. Section 16412 - Low Voltage Molded Case Circuit Breakers.
8. Section 16422 - Motor Starters.
9. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

## 2.08 ACCESSORIES

A. Wiring:
1. Wire the motor control center in accordance with the following NEMA Class and Type as defined by NEMA ICS 18-2001:
   a. NEMA Class II-S:
      1) Furnish wiring diagrams for individual units consisting of drawings that identify electrical devices, electrical connections, and indicate terminal numbering designations.
      2) Furnish individual unit diagrams with each unit and include inter-wiring between units, i.e., electrical interlocking, etc., as specifically specified in the Contract Documents.
      3) Provide custom drawings with unique terminal numbering designations in lieu of standard manufacturer drawings.
   b. NEMA Type B wiring:
      1) Control wiring:
         a) Type B-T pull-apart terminal blocks.
      2) Power wiring:
         a) Type B-T for Size 1 starters.
         b) Type B-T or B-D for Size 2 and 3 starters.
         c) Type B for Size 4 and larger starters and feeder units.

B. Lugs and terminals:
1. For external connections of No. 6 AWG wire or larger:
   a. UL listed for copper or aluminum conductors.
2. Compression type, requiring a hydraulic press and die for installation.
3. Provide additional terminal blocks as needed for control conductors passing through the MCC.
4. Provide 30 percent spare control block terminals.

C. Nameplates:
   1. Provide nameplates as specified in Section 16075 - Identification for Electrical Systems:
      a. Identifying the motor control center designation as indicated on the Drawings.
   2. Furnish individual nameplates for each unit indicated on the Drawings:
      a. 1 nameplate to identify the unit designation.
      b. 1 nameplate to identify the load served.
      c. Furnish space units with blank nameplates.
   3. Manufacturer's labels:
      a. Furnish each vertical section with a label identifying:
         1) Serial number.
         2) Bus rating.
         3) Vertical section reference number.
         4) Date of manufacture.
         5) Catalog number of section.

## 2.09 FINISHES

A. Finish metal surfaces and structural parts with phosphatizing, or equal, treatment before painting.

B. Finish interior surfaces including bus support angles, control unit back plates, and top and bottom barrier plates with baked white enamel.

C. Finish exterior of enclosure with manufacturer's standard gray.
   1. Finish NEMA Type 3R exterior cabinets with ultraviolet resistant enamel paint that is UL recognized for outdoor use.

## 2.10 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory test on motor control centers prior to shipment.

# PART 3 EXECUTION

## 3.01 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.02 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish cables, conduit, lugs, bolts, and other accessories necessary to completely install the motor control center for the line, load, and control connections.
   2. Assemble and install the motor control center in the locations and with the layouts as indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform work in accordance with manufacturer's instruction and Shop Drawings.
   5. Furnish components and equipment necessary to complete the installation.
   6. Replace hardware, lost or damaged during installation or handling, in order to provide a complete installation.
   7. Install the MCC on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units:
         1) Remove the manufacturer's supplied mounting channels as required by the manufacturer's installation instructions.
      b. Weld and/or bolt the motor control center frame to leveling channels.

C. Provide openings in the top or bottom of the motor control center for conduit only:
   1. No additional openings will be accepted:
      a. Miscut holes will require that the entire vertical section or removable panel be replaced.
      b. No hole closers or patches will be accepted.

D. Bundle circuits together and terminate in each unit:
   1. Tie with nylon wire ties as specified in Section 16123 - 600-Volt or Less Wires and Cables.
   2. Label wires at each end with wire markers as specified in Section 16075 - Identification for Electrical Systems as shown on the approved elementary schematics.

## 3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing (Factory Acceptance Tests):
   1. Not witnessed.
   2. Test the complete motor control center at the manufacturer's establishment. Completely assemble, wire and test the motor control center:
      a. Detailed inspections before and after assembly to ensure correctness of design and workmanship.
   3. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
   4. Furnish test reports and Manufacturer's Certificate of Source Testing.

C. Installation Verification:
   1. Furnish Manufacturer's Certificate of Installation Verification.

D. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

E. Owner Training:
   1. Not required.

## 3.04 FIELD QUALITY CONTROL

A. Provide the services of a manufacturer's representative to:
   1. Inspect, verify, and certify that the motor control center installation meets the manufacturer's requirements.

## 3.05 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

END OF SECTION

## SECTION 16445

## PANELBOARDS

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Panelboards serving feeder circuits and branch circuits.

## 1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).

C. Underwriters Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

## 1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

## 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of panelboard.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase.
      c. Continuous current.
      d. Short circuit interrupting rating.
   4. NEMA enclosure type.
   5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.
   6. Furnish circuit breaker Submittals as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
   7. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
      a. Manufacturer’s statement of seismic qualification with substantiating test data.
      b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop Drawings:
1. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
   a. Height.
   b. Length.
   c. Width.
2. Weight.
3. Anchoring locations.
4. Breaker layout drawing with dimensions:
   a. Location of the main, branches, solid neutral, and ground.
5. Conduit entry/exit locations:
   a. Identify conduit entry/exit locations and restrictions.
6. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for every panelboard.

D. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
   a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
   b. For equipment installed outdoors.
   c. For wall mounted equipment weighing 125 pounds or more.

E. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. Provide manufacturer's installation instructions.

F. Commissioning Submittals:
1. As specified in Section 01756 - Commissioning, including the following:
   a. Certificates:
      1) Requirements as specified in this Section.
   b. Test Plans:
      1) Test requirements as specified in this Section.
   c. Test Reports.

G. Operations and maintenance manual:

1. As specified in Section 01782 - Operation and Maintenance Manuals.
2. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories:
   a. Including, but not limited to:
      1) Instruction narratives and bulletins.
      2) Renewal parts lists.
      3) Time-current curves for all devices.

H. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the panelboard to prove the panelboard is suitable for the seismic requirements at the Project Site.

## 1.05 QUALITY ASSURANCE

A. Where indicated as service entrance equipment, panelboards shall be UL listed and labeled “Suitable for Service Entrance.”

## 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:
   1. Service voltage and configuration as indicated on the panel schedules.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

B. Circuit breakers:
   1. Same manufacturer as the panelboard.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Provide panelboards with:
   1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
   2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.
      a. Space for future devices as specified in Section 16050 - Common Work Requirements for Electrical.

B. Short circuit rating:
   1. Provide as indicated on the Drawings.
   2. Testing method in accordance with UL 67.
   3. Mark each panelboard with its maximum short circuit rating at the supply voltage.
   4. Panelboards shall be fully rated.

## 2.07 COMPONENTS

A. Enclosure:

   1. NEMA enclosure type as indicated on the Drawings:
      a. Where not indicated on the Drawings, as specified in Section 16050 - Common Work Results for Electrical for the installed location.
   2. Minimum width: 20 inches.
   3. Gutter space in accordance with the NEC:
      a. Minimum of 4 inches.
   4. Dead-front, no live parts when the panelboard is in service.
   5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.
   6. 4-piece front to provide ease of wiring access.
   7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull:
      a. Minimum 2 keys per panelboard.
      b. Key all panelboard locks alike:
         1) Match locks on existing panelboards to the extent possible.
   8. Circuit directory frame and card on the inside of the door.
   9. Door-in-door construction consists of a one-piece front with 2 doors:
      a. Smaller door provides access to device handles and rating labels and shall be lockable.
      b. Larger door provides access to conductors and wiring terminals.
   10. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
   11. Outdoor locations: Provide NEMA Type 4X enclosures with a NEMA Type 4X stainless steel outer enclosure (with a hinged door) and a NEMA Type 1 interior panelboard, unless otherwise indicated.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.
      b. Dimensions and temperature rise in accordance with UL 67:
         1) Limit current density to less than 1,000 amps per square inch.
      c. Insulate current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
   3. Ground bus:
      a. Copper, solidly bonded.
   4. Neutral bus:
      a. Provide where indicated on the Drawings.
      b. 100 percent rated.
      c. Provide lugs for each outgoing feeder requiring a neutral connection.
   5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

C. Lugs:
   1. UL listed for copper and aluminum wire:
      a. Rated for 75-degree Celsius terminations.
      b. Provide bolted or compression main lug terminations as required for the incoming cable size.

D. Circuit breakers: As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers and as indicated on the Drawings:
   1. Provide with bolt-on connections:
      a. Plug-in circuit breakers are not allowed.

## 2.08 ACCESSORIES

A. Surge protective devices:
   1. Furnish panelboards with surge protective devices as indicated on the Drawings.
   2. As specified in Section 16285 - Surge Protective Devices.

B. Nameplates:
   1. As specified in Section 16075 - Identification for Electrical Systems.
   2. Install on outside of door.
   3. Indicating:
      a. Panel designation.
      b. Voltage.
      c. Number of phases and configuration.

C. Circuit identification labels:
   1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.
   2. Type all information on the cards using designations in the panel schedules.
   3. Laminated on both sides.

D. Pad locking mechanism:
   1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.
   2. At a minimum, provide 1 mechanism per panelboard:
      a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

## 2.09 FABRICATION (NOT USED)

## 2.10 FINISHES

A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with manufacturer’s standard gray.

B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Mounted as indicated on the Drawings.
   2. Mount rigidly to structural members with exposed surfaces plumb and level to within 1/32 inch.
   3. Perform Work in accordance with the manufacturer’s instructions and Shop Drawings.
   4. Provide brackets, hangers, supports, and hardware for mounting as required.
   5. In NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:
      a. Use only stainless steel mounting hardware.
   6. Mount panelboard so that top operating handle is not more than 6 feet and 7 inches above the operating floor.

C. Provide typewritten schedule in each panelboard.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source Testing:
   1. Perform standard factory tests on the panelboards.
   2. Test in accordance with NEMA and UL standards.
   3. Furnish test reports and Manufacturer’s Certificate of Source Testing.

C. Functional Testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

## 3.05 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

END OF SECTION

## SECTION 16472

## PACKAGED POWER SUPPLY CENTER

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. Packaged power supply centers, a single integrated unit composed of:
      a. Primary main breaker.
      b. Dry-type transformer.
      c. Branch circuit panelboard with main breaker.

## 1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. National Electrical Manufacturers Association (NEMA).

C. Underwriters Laboratories, Inc. (UL):
   1. 50 - Standard for Enclosures for Electrical Equipment.
   2. 67 - Standards for Panelboards.

## 1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

## 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase/wire.
      c. Continuous current.
      d. Short circuit interrupting rating.
      e. Transformer kVA rating.
   4. NEMA enclosure type.
   5. Catalog sheets for circuit breakers contained within the panelboard.
   6. Cable terminal sizes based upon actual feeder and branch circuit conductors used.
   7. Furnish circuit breaker Submittals as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

8. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 01850 - Design Criteria:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Including, but not limited to:
    a. Overall dimensions, interior panel dimensions, and wiring gutter dimensions:
        1) Height.
        2) Length.
        3) Width.
    b. Weight.
    c. Anchoring locations.
    d. Breaker layout drawing with dimensions:
        1) Location of the main, branches, solid neutral, and ground.
    e. Conduit entry/exit locations.
    f. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for each and every panelboard.

D. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the packaged power supply center to prove suitability for the seismic requirements at the Project Site as specified in Section 01850 - Design Criteria.

E. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
    a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
    b. For equipment installed outdoors.
    c. For wall mounted equipment weighing 125 pounds or more.

F. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
1. Manufacturer's representative qualifications.
2. Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
3. Test reports.

H. Operations and maintenance manual:
1. As specified in Section 01782 - Operation and Maintenance Manuals.

2. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories, including, but not limited to:
   a. Instruction narratives and bulletins.
   b. Renewal parts lists.

## 1.05 QUALITY ASSURANCE

A. Where indicated as service entrance equipment:
   1. UL labeled and listed “Suitable for Service Entrance.”

## 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Packaged power supplies centers are an integral unit that provides a means for:
   1. Transforming the distribution voltage level to the utilization voltage level.
   2. Primary and secondary protection for the transformer.
   3. Distribution of secondary power.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. Eaton.
   3. Schneider Electric.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. Enclosure:
   1. Enclose entire unit including panelboard bus assembly, main breakers, and transformer in a galvanized steel cabinet:
      a. Rated NEMA Type 3R, suitable for indoor/outdoor use.
      b. Steel gauge in accordance with UL 50.
      c. Wire gutter space in accordance with UL 67.
   2. Hinged access door:
      a. Maintained in open position when desired.
      b. With padlock provisions to prevent unauthorized entry.
   3. Dead-front panelboard construction.

B. Panelboard:
   1. Bus:
      a. General:
         1) Tin-plated copper.
      b. Phase bus:
         1) Fully rated for the associated transformer.
         2) Full size without reduction.
      c. Neutral bus:
         1) Ampere rating to match phase bus.
         2) Provide with suitable lugs for the maximum number of circuits that can be connected to the panel.
      d. Ground bus:
         1) Provide suitable lug space to provide a lug for each circuit including spaces.
   2. Label panelboards with UL short circuit current rating.

## 2.07 COMPONENTS

A. Primary and secondary main breakers:
   1. Sized to protect the transformer.
   2. Integrally mounted and wired.
   3. Provide as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
   4. Minimum interrupting rating as indicated on the Drawings, but not less than:
      a. Primary main breaker: 480 VAC, 18,000 AIC.
      b. Secondary main breaker: 120/240 VAC, 10,000 AIC.

B. Branch circuit breakers:
   1. As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
   2. Match circuit breaker arrangement to the panel schedules as indicated on the Drawings.
   3. Circuit breakers shall not be restricted to any mounting location due to their physical size.
   4. Install circuit breakers such that they can be replaced without disturbing adjacent units.
      a. Provide wire connectors suitable for wire sizes indicated on the Drawings.

C. Transformer:
   1. General:
      a. Minimum of two 5 percent full capacity primary taps below normal.
      b. Insulation:
         1) Insulating materials for a 185-degree Celsius UL component recognized insulation system.
         2) 115 degrees Celsius temperature rise above 40 degrees Celsius maximum ambient.
      c. Fully encapsulated using a sand-epoxy resin mixture to provide maximum protection against moisture, dust, and corrosive environments.
   2. Configuration:
      a. Single- or 3-phase, as indicated on the Drawings.
      b. kVA rating as indicated on the Drawings.
      c. Primary voltage: 480 VAC.
      d. Secondary voltage: As indicated on the Drawings.

**2.08 ACCESSORIES**

A. Provide nameplates as specified in Section 16075 - Identification for Electrical Systems.

B. Circuit identification labels:
   1. Index cards behind heavy clear plastic in card holders on inside of doors:
      a. Type all information on cards.
   2. Laminated on both sides.
   3. Circuit identification to follow panel schedules as indicated on the Drawings.

**2.09 MIXES (NOT USED)**

**2.10 FABRICATION (NOT USED)**

**2.11 FINISHES (NOT USED)**

**2.12 SOURCE QUALITY CONTROL**

A. Source Testing:
   1. Perform the following factory tests. All tests shall be in accordance with the latest version the applicable of ANSI and NEMA standards.
      a. Ratio tests at the rated voltage connection and at all tap connections.
      b. Polarity and phase-relation tests on the rated voltage connection.
      c. Applied potential tests.
      d. Induced potential test.
      e. No-load and excitation current at rated voltage on the rated voltage connection.
   2. Furnish test reports and Manufacturer's Certificate of Source Testing.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

### 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Provide brackets, hangers, supports, and hardware for mounting in the location as indicated on the Drawings.

C. In wet and damp locations, mount assembly on 7/8-inch-deep stainless steel preformed mounting channel:
   1. Channel shall run vertically from top to bottom of unit.

### 3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

### 3.05 OWNER TRAINING (NOT USED)

### 3.06 ADJUSTING

A. Set transformer taps as required.

END OF SECTION

**SECTION 16491**

**TRANSFER SWITCHES**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Transfer switches.

### 1.02 REFERENCES

A. Abbreviations:
   1. ATS: Automatic transfer switch.
   2. MTS: Manually initiated, electrically operated transfer switch.

B. Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
   2. Underwriters Laboratories (UL):
      a. 1008 - Transfer Switch Equipment.

### 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. SCCR: Short-circuit current rating, the maximum short-circuit current a component and assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.
   2. WCR: Withstand and closing rating, represents a transfer switch's capability to ride out a fault condition until the overcurrent protective device opens and clears the fault.

### 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing.

### 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer of transfer switch.
   2. Manufacturer of component parts of the ATS.
   3. Dimensions:
      a. Width.
      b. Length.

c. Height.
d. Weight.
4. Bill of material.
5. Description of operation.
6. Ratings:
a. Voltage.
b. Phase.
c. Current.
d. Number of poles.
e. Withstand and closing rating (WCR).
7. List of recommended spare parts.
8. For equipment installed in structures designated as Seismic Design Category C, D, E, or F, submit the following as specified in Section 01850 - Design Criteria:
a. Manufacturer's statement of seismic qualification with substantiating test data.
b. Manufacturer's special seismic certification with substantiating test data.

C. Shop Drawings:
1. Layout drawings:
a. Furnish full-dimension and to-scale equipment layout drawings, which include:
1) Plan, front, and side views.
2) Sub-panels.
3) Interior panels.
4) Top and bottom conduit windows.
2. Complete electrical wiring diagrams:
a. Point-to-point connections.
b. Indicate wire numbers.
3. Complete interface and connection diagrams.
4. Transfer equipment label indicating the short-circuit current rating (SCCR).

D. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the transfer switch to prove the transfer switch is suitable for the seismic requirements at the Project Site.

E. Delegated Design Submittals:
1. Anchoring and bracing: Provide project-specific calculations based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria:
a. To structures for equipment installed in structures designated as seismic design category C, D, E, or F.
b. For equipment installed outdoors.
c. For wall mounted equipment weighing 125 pounds or more.

F. Installation instructions:
1. Detail the complete installation of the equipment, including rigging, moving, and setting into place.
2. Provide manufacturer's installation instructions.

G. Quality Control Submittals:
   1. Manufacturer's representative qualifications.
   2. Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   3. Manufacturer's Certificate of Installation Verification as specified in Section 01756 - Commissioning.
   4. Test reports.

H. Owner Training Submittals:
   1. As specified in Section 01756 - Commissioning.

I. Operation and maintenance manuals:
   1. As specified in Section 01782 - Operation and Maintenance Manuals.
   2. Operating instructions:
      a. Printed and framed instruction chart suitable for wall hanging.
      b. Detail the operational functions of transfer switch controls.
   3. Maintenance manual:
      a. Furnish maintenance manuals with instructions covering maintenance of equipment and data identifying all parts.
      b. Furnish information needed to maintain the transfer switch, including, but not limited to, the following:
         1) Instructions for testing, adjustment, and start-up.
         2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
         3) Description of the sequence of operation that outlines the steps that follow normal power failure, transfer to standby power, return to normal power, and fault conditions.
         4) Schematics and wiring:
            a) Furnished in a reduced 11-inch-by-17-inch fully legible format.
         5) Report listing the installed setting of adjustable parameters for the automatic transfer system.

## 1.06 QUALITY ASSURANCE

A. Where indicated on the Drawings, the transfer switch shall be UL labeled and listed "Suitable for Service Entrance".

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Ship the transfer switch to the job site on a dedicated air-ride vehicle that will allow the Contractor to utilize on-site off-loading equipment.

B. Furnish temporary equipment heaters within the transfer switch to prevent condensation from forming.

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Provide transfer switches capable of transferring load circuits from utility power to standby power and back.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide equipment and components that are fully rated for the Site elevation and operating environment where the equipment will be installed as specified in Section 01850 - Design Criteria and as indicated on the Drawings.

B. Non-conditioned spaces:
   1. Provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.

C. Outdoor installations:
   1. Provide conditioning equipment incorporated into the equipment to maintain the enclosures within the equipment manufacturer’s specified operating ranges.

D. ATS sequence of operation:
   1. When the voltage of any normal source phase drops below 80 percent and after an adjustable time delay (0 to 6 seconds minimum), the transfer switch shall start the standby generator.
   2. When standby voltage reaches 90 percent of nominal, and frequency is within 2 hertz of nominal, following an adjustable time delay (0 to 10 seconds), the switch shall transfer to standby power.
   3. When normal power has been restored to 90 percent of nominal on all phases, following an adjustable time delay (0 to 30 minutes), the switch shall retransfer to normal power:
      a. If the standby source fails during this time delay, the switch shall automatically retransfer to normal power.
   4. Following an adjustable generator cool-down timer (0 to 60 minutes), the switch shall stop the generator.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. ABB.
   2. ASCO.
   3. Eaton.

4. Russelectric, Inc.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. General:
   1. Capable of switching all classes of load.
   2. Rated for continuous duty when installed in a non-ventilated enclosure.
   3. Provide circuit breakers or contactors rated for continuous duty.
   4. Minimum transfer time for delayed transition ATS: 1 second.
   5. Capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
   6. Provide automatic transfer switches with provisions for manual operation under no load.
   7. Transfer switch short circuit rating to be coordinated with the overcurrent protective devices at the fault current available on the line side of the transfer switch.

B. Electrical ratings:
   1. Voltage, configuration, and amp ratings as indicated on the Drawings.
   2. WCR in accordance with UL 1008.

C. Contacts:
   1. Mechanically held.
   2. Mechanically interlocked to prevent normal and standby sources from being closed at the same time.
   3. Silver alloy construction.
   4. Neutral contact, when indicated on the Drawings:
      a. Same ratings as the phase contacts.
      b. Break last and make first operation.

D. Controls:
   1. ATS shall have 3-phase over-voltage, under-voltage, over-frequency, and under-frequency on both normal and standby sources.
   2. Control panel:
      a. Microprocessor based.
      b. 4-line, 20-character LCD display. Displayed data shall include:
         1) Normal and standby source parameters.
         2) Diagnostic information.
         3) Switch and timer status.
      c. Keypad for making ATS settings and operating parameters:
         1) Settings shall be password protected.
      d. LED display of the following:
         1) Normal source available.
         2) Connected to normal source.
         3) Standby source available.
         4) Connected to standby source.
      e. Provisions for testing ATS operation by simulating a normal source failure.

f. Generator exerciser:
   1) Programmable to start the generator on a daily, weekly, monthly, or yearly basis for an adjustable period of time.
   2) Load or no load selectable:
      a) When load is selected, ATS will transfer to the generator for the duration of the exercise period. Re-transfer back and cool down the generator.
      b) When no load is selected, the ATS will run the generator for the duration of the exercise period and then stop the generator.

3. Status and control contacts:
   a. Generator start/stop contact:
      1) Single-pole, double-throw.
      2) Rated for 5 amps at 30 VDC.
   b. Status contacts:
      1) Single-pole, double-throw.
      2) Rated for 10 amps at 250 VAC.
      3) Provide contacts for the following:
         a) Normal source available.
         b) Normal source failure.
         c) Connected to normal source.
         d) Standby source available.
         e) Standby source failure.
         f) Connected to standby source.

E. Enclosure:
   1. NEMA 3R.

## 2.07 COMPONENTS (NOT USED)

## 2.08 ACCESSORIES

A. Space heater:
   1. Provide a thermostatically controlled space heater in NEMA 3R enclosures.
   2. Integrally powered from the switch.

## 2.09 SOURCE QUALITY CONTROL

A. Source Testing:
   1. Complete factory test to verify proper operation of timers, settings, and operation.
   2. Furnish test reports and Manufacturer’s Certificate of Source Testing.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).
   2. Install anchors of type and material indicated on approved anchoring designs.
   3. Install anchors with embedment indicated on approved anchoring designs.

### 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. General:
   1. Furnish components and equipment as required to complete the installation.
   2. Replace hardware lost or damaged during the installation or handling to provide a complete installation.
   3. Install the transfer switch on a raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer’s recommendations to provide proper alignment of the units.
      b. Weld and/or bolt the transfer switch frame to the leveling channels.
   4. Provide openings in top or bottom of the enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.

C. Furnish Manufacturer’s Certificate of Installation Verification.

### 3.04 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Field electrical acceptance testing:
   1. As specified in Section 16950 - Field Electrical Acceptance Tests.

### 3.05 OWNER TRAINING

A. Not required.

END OF SECTION

## SECTION 16494

## LOW VOLTAGE FUSES

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Fuses: 600-volt class and lower.

### 1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures.

B. Product data:
   1. Catalog cut sheets.
   2. Complete fuse schedule.
   3. Manufacturer original 11-inch by 17-inch, time current curves for all fuses furnished.

C. Shop drawings:
   1. Include drawings of spare fuse cabinets.

### 1.05 QUALITY ASSURANCE

A. All low voltage fuses shall be UL listed and labeled.

### 1.06 DELIVERY, STORAGE, AND HANDLING (NOT USED)

### 1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

### 1.08 ADMINISTRATIVE REQUIREMENTS (NOT USED)

### 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

## 1.10 MAINTENANCE

A. Spare parts:
   1. Provide 3 spare fuses for each size and type used or supplied under any Section of the Contract Documents.
   2. Provide spare fuse cabinet(s):
      a. Metal cabinet with hinged door and shelves or fuse holders.
      b. Gray enamel finish.
      c. Mount near equipment and label "Spare Fuses" on face of cabinet.
      d. Suitable pocket inside door of each cabinet with typewritten spare fuse inventory in clear plastic protective insert.
      e. Provide as many cabinets as required to hold entire spare fuse inventory.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Fuses for overcurrent protection and/or current limiting applications as indicated on the Drawings.

## 2.02 DESIGN AND PERFORMANCE CRITERIA (NOT USED)

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. Bussmann.
   2. Ferraz Shawmut.
   3. Littelfuse.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS

A. General:
   1. Provide durable, readily visible label inside each fuse enclosure, clearly indicating the correct type, size, and ratings of replacement fuse:
      a. Label shall not cover or interfere with equipment manufacturer's instructions.
   2. Affix a label indicating recommended torque for fuse mounting bolts or studs to the inside of fuse access doors.
   3. To ensure selective coordination of protective devices:
      a. Provide fuses for new facilities by the same manufacturer.
      b. Provide fuses for renovations of the same manufacturer as existing fuses.
   4. Provide fuses rated for the voltage and available short circuit current at which they are applied.

B. Fuses for services, switchboard mains, feeders, and branch circuits:
   1. 600 amperes and less:
      a. Provide UL listed RK1 dual-element, time-delay fuses with ampere ratings as indicated on the Drawings except as may be modified by the Contract Documents.
   2. 601 to 6,000 amperes:
      a. Provide UL listed Class L fuses.

C. Fuses for motor branch circuits:
   1. Ampere ratings shall not exceed motor controller manufacturer’s recommended values:
      a. If manufacturer does not have such standards, provide fuses as specified in this Section.
   2. Provide Class RK1 fuses or fuses as indicated on the Drawings and as specified in the Contract Documents, rated in accordance with the fuse manufacturer’s recommendations for backup running protection of motor circuits containing overload relays.
   3. Determine fuse ratings for overload protection of motor branch circuits by actual full-load currents of motors provided.
   4. Fuses in motor control centers may be time-delay Class J or Class CC fuses, if MCC manufacturer’s standard designs use these fuse types:
      a. Time-delay Class J fuse ratings shall not exceed 150 percent of motor full load current except as permitted.
      b. Follow fuse manufacturer’s recommendations for Class CC fuses.
      c. A motor having starting duty or other special characteristics requiring larger fuses than specified above, may have branch circuit fuse ratings increased as necessary to meet motor’s requirements, but no larger than maximum permitted by the NEC.
         1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.
   5. Provide Class L fuses for motor branch circuits requiring fuses over 600 amperes, sized at 150 percent of motor full load current except as permitted below:
      a. A motor having starting duty or other special characteristics requiring larger fuses than specified above, may have branch circuit fuse ratings increased as necessary to meet motor’s requirements, but no larger than maximum permitted by the NEC.
         1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.

D. Fusing of control circuits:
   1. Provide:
      a. RK1 fuses installed in UL listed Class CC fuse blocks as specified in the Contract Documents.
   2. Provide minimum protection for control circuits in accordance with the latest revision of UL Standard 508 for Industrial Control.
   3. Fuse both the primary and secondary circuit of control power transformers:
      a. Fuse ratings shall be in accordance with NEC requirements.

## PART 3 EXECUTION

### 3.01 EXAMINATION (NOT USED)

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. General:
   1. Install fuses properly aligned, electrically and mechanically secure.
   2. Evenly torque mounting bolts and nuts to ASTM recommendations for type and diameter of mounting bolts or studs provided.
   3. Paralleling of fuses is not permitted.
   4. Install fuses so that the fuse nameplate and rating are easily readable in the equipment.

B. Replace fuses, on all phases, for any fuses that opened during start-up and testing.

C. After completion of testing, deliver spare fuses in quantities specified:
   1. Fuses shall be new, in manufacturer's original packaging, and stored in a clean, dry location.

D. Install spare fuse cabinets where instructed by the Owner.

### 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

END OF SECTION

SECTION 16510

LIGHTING: LED LUMINAIRES

# PART 1 GENERAL

## 1.01 SUMMARY

A. Section includes:
   1. LED luminaires, drivers, poles, and accessories.

## 1.02 REFERENCES

A. Illuminating Engineering Society (IES):
   1. LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
   2. LM-80 - Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
   3. RP-7 - Recommended Practice for Lighting Industrial Facilities.
   4. TM-21 - Projecting Long Term Lumen, Photon, and Radiant Flux Maintenance of LED Light Sources.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

C. National Electrical Code (NEC).

D. National Electrical Manufacturers Association (NEMA):
   1. 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.

E. Underwriters Laboratories (UL):
   1. 1598 - Luminaires.
   2. 8750 - Light Emitting Diode (LED) Equipment for Use In Lighting Products.

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. CCT (correlated color temperature) - Scientific scale to describe how “warm” or how “cool” the light source is, measured in Kelvin. The lower the Kelvin temperature, the warmer the light feels, or appears.
   2. CRI (color rendering index) - A quantitative measure of the ability of a light source to reveal the colors of various objects faithfully in comparison with an ideal or natural light source.
   3. Driver - Device that manages power and controls the current flow from AC to DC for an LED lighting product.

4. Efficacy - Lumen output of a light source per unit of power supplied to that source (lumens per watt).
5. EMI (electromagnetic interference) - Electrical interference (noise) generated by electrical and electronic devices.
6. FC (foot candles) - Measure of light level on a surface being illuminated.
7. L70 - The extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
8. LED (light emitting diode) - A solid-state semiconductor device that produces light when electrical current flows through it.
9. LED light source - See LED luminaire.
10. LED luminaire - A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit.
11. Lumen - The international (SI) unit of luminous flux or quantity of light. The amount of light that is spread over a square foot of surface by 1 candle power when all parts of the surface are exactly 1 foot from the light source.
12. Lumen ambient temperature multiplier - LED light source relative lumen output when compared to a standard ambient temperature.
13. Lumen maintenance factor - How well an LED light source is able to retain its intensity when compared to new.
14. Luminaire - Lighting unit.
15. THD (total harmonic distortion) - The combined effect of harmonic Distortion on the AC waveform produced by a driver or other device.

## 1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Anchoring and bracing for light poles.

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. LED Luminaires:
      a. Catalog literature for each luminaire specified, cross-referenced to the luminaire type on the Luminaire Schedule in the Drawings.
      b. Provide for each luminaire type:
         1) Materials.
         2) Type of diffuser.
         3) Hardware.
         4) Gasketing.
         5) Reflector.
         6) Chassis.
         7) Finish and color.
         8) Driver type and protection.
         9) LED luminaire:
            a) Initial lumen output at 40 degrees Celsius ambient.
            b) Correlated color temperature.

c) Lumen maintenance factors.
d) Lumen ambient temperature multipliers.
e) Drive current.
f) Efficacy.

10) Picture of luminaire.
11) IES optical distributions.
12) Dimensioned drawings:
    a) Effective projected area rating for pole mounted luminaires.
13) Weight.
14) Photometric data:
    a) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
    b) Luminaire dirt depreciation factor.
    c) Candlepower distribution curves.
    d) Average luminaire brightness.
    e) Lumen output charts.
15) Furnish support method for interior luminaires weighing more than 30 pounds and all wall-mounted luminaires:
    a) Support methods shall be based on seismic requirements at the project site as specified in Section 01850 - Design Criteria.

c. Luminaire substitutions:
   1) Provide complete literature for each luminaire substitution:
   2) Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
      a) Photometric data:
         (1) IES file in standard IES format.
         (2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
         (3) Candlepower distribution curves.
         (4) Average luminaire brightness.
         (5) Lumen output charts.
         (6) Power requirements in watts and volt-amperes.
      b) Calculations:
         (1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
             (a) Use surface reflectance values in accordance with IES RP-7.
             (b) Use manufacturer Projected Lumen Maintenance factor for minimum of 60,000 hours to perform all calculations.
      c) Specification sheets:
         (1) If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer’s complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications

necessary to meet the requirements of the contract documents.

3) Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
4) Substitutions shall comply with all applicable building and energy codes.

2. Driver: Provide for each driver type:
   a. Catalog number.
   b. Type of driver.
   c. Output wattage.
   d. Input voltage.
   e. Operating voltage range.
   f. Maximum input power.
   g. Efficiency.
   h. Operating line current.
   i. Power factor.
   j. Operating temperature range.
   k. Current output range in ambient temperatures of 30 to 55 degrees Celsius.
   l. Surge suppression data.
3. Photocell:
   a. Provide for each photocell type:
      1) Switching capacity.
      2) Life expectancy when used on LED sources.
      3) The means of adjusting the lighting pickup level.
      4) Enclosure type.
      5) Mounting method.
4. Luminaire poles:
   a. Submit complete data for each pole type including, but not limited to:
      1) Material.
      2) Finish and color.
      3) Handholes.
      4) Anchoring.
      5) Luminaire attachment methods and fittings.
      6) Pole height.
      7) Pole dimensions.
      8) Bolt hole circle layout and hardware.
      9) Accessories.
      10) Provide the EPA wind load rating.
      11) Installation instructions for rigging, moving and setting into place.

C. Delegated Design Submittals:
   1. Project-specific calculations with anchoring and bracing details based on support conditions and requirements to resist loads specified in Section 01850 - Design Criteria.

D. Record documents:
   1. Update the Luminaire Schedule in the Drawings to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

## 1.06 QUALITY ASSURANCE

A. Luminaires shall be UL listed and labeled.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. Scheduling:
   1. Exterior and outdoor lighting system operation shall be demonstrated during the hours of darkness.
   2. Lighting demonstration shall occur within 2 weeks before substantial completion.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. LED luminaire:
   1. 5-year warranty from the date of installation including material, workmanship, photometrics, driver, and LED modules.

## 1.11 MAINTENANCE

A. Furnish 1 complete spare LED luminaire, with driver, of each type used.

# PART 2 PRODUCTS

## 2.01 GENERAL

A. Individual luminaire types are indicated on the Drawings and on the Luminaire Schedule.

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide luminaires and accessories for all lighting systems, complete and operable, in accordance with the requirements of the Contract Documents.

## 2.03 MANUFACTURERS

A. Luminaires:
   1. The following or equal:
      a. As noted on the Luminaire Schedule.

B. Drivers:
   1. One of the following or equal:
      a. eldoLED.
      b. Philips Advance.

c. Thomas Research.

C. Photo-electric cells:
   1. One of the following or equal:
      a. Cooper.
      b. Intermatic.
      c. Tork.

D. Substitutions:
   1. The lighting design and luminaire selection has been based upon the photometric data of the identified luminaire. It is the Contractor's responsibility to ensure and prove to the Engineer at time of Submittal the substitutions meet the quality and photometric requirements of the original design.

## 2.04 MATERIALS (NOT USED)

## 2.05 MANUFACTURED UNITS (NOT USED)

## 2.06 EQUIPMENT

A. LED luminaires:
   1. General:
      a. Pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
      b. Provide the luminaires furnished as indicated on the Luminaire Schedule in the Drawings:
         1) The Specifications noted in this Section are an addition or supplement to the Luminaire Schedule.
      c. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire.
   2. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius.
   3. Minimum rated life:
      a. Office areas: 70,000 hours when operated at 25 degrees Celsius.
      b. Process areas: 100,000 hours when operated at 40 degrees Celsius.
      c. Hazardous areas: 100,000 hours when operated at 40 degrees Celsius.
   4. Minimum efficacy of 70 lumens/watt.
      a. Hazardous areas: Minimum 60 lumens/watt.
   5. Minimum Color Rendering Index of 70.
   6. Tested according to IES LM-79 and LM-80.
   7. Lumen maintenance projection in accordance with IES TM-21.
   8. RoHS compliant.
   9. Integral driver.
   10. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule.
       a. Wet or damp locations: UL 1598 listed.
   11. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used.

12. Exterior/outdoor luminaires:
    a. Luminaires in combination with their mounting pole and bracket shall be capable of withstanding:
        1) Wind levels at the project site without damage.
        2) Seismic levels at the project site.
    b. Corrosion-resistant hardware and hinged doors or lens retainer.
    c. Luminaires furnished with integral photoelectrical control shall be of the luminaire manufacturer's standard design.

13. Luminaires in hazardous areas:
    a. In accordance with NEC Section 500 requirements.
    b. UL labeled and identified for hazardous area.
    c. Marking on Class I and II Division 1 and 2 areas shall identify the applicable material classification group.
    d. Marking shall include the temperature class (T code).

B. Photo-electric cells:
1. Photoelectric cells for control of multiple luminaires:
    a. Self-contained.
    b. Weatherproof.
    c. Provided with time-delay features.
    d. Sized to meet switching capacity of the circuit:
        1) Based on luminaire VA as indicated on the Drawings.
2. Photoelectric cell for control of a single luminaire:
    a. Integral to the luminaire.

C. Luminaire control:
1. Lighting control relays or contactors as specified in Section 16422 - Motor Starters.

D. Drivers:
1. Dimmable, with dimming signal protocol of 0-10 VDC or DALI.
2. Input power source:
    a. As indicated on the Drawings.
3. Drive current:
    a. As indicated in the Luminaire Schedule.
4. Power factor: Greater than 0.90.
5. Efficiency: Greater than 80 percent.
6. Total harmonic distortion (THD) of the input current less than 20 percent.
7. Rated life of 60,000 hours in an LED luminaire operated at an ambient temperature of 40 degrees Celsius.
8. Minimum operating temperature of -40 degrees Celsius.
9. Sound rating: Class A+ or quieter.
10. UL listed Class 2 Outdoor in accordance with UL 8750.
11. In accordance with IEEE C62.41 Category A for transient protection.
12. Driver must limit inrush current:
    a. Meet or exceed NEMA 410 driver inrush standard:
        1) 230 Amps per 10 Amp load with a maximum of 106 Amps squared-seconds at 120 V.
        2) 430 Amps per 10 Amp load with a maximum of 370 Amps squared-seconds at 277 V.

## 2.07 COMPONENTS

A. Luminaire poles:
   1. As indicated on the Luminaire Schedule.
   2. Anchor bolts:
      a. Use anchor bolts, bolts, or welded studs for anchors for resisting seismic and wind forces.
         1) Standard hex bolt head.
         2) Do not use anchor bolts fabricated from rod stock with an L- or J-shape.
      b. Complete with leveling shims.
   3. Anchor base:
      a. Fabricated from the same type of material as the pole shaft.
      b. Base plate to telescope the pole shaft.
      c. Welded top and bottom along the entire perimeter.
      d. With slotted bolt holes on the bolt circles as submitted.
   4. Pole shaft:
      a. As indicated on the Luminaire Schedule.
   5. Handhole:
      a. Reinforced handhole located approximately 18 inches above the base.
      b. Complete with cover fabricated from the same material as the pole shaft and stainless steel attachment screws.
      c. With an integral ground connection nut, 1/2 inch by 13 inch UNC welded to the pole for connection to the grounding system.
   6. Shroud:
      a. Fabricated from the same type of material as the pole shaft.
      b. 1-piece formed channel section that shall conform to the pole shaft taper.
      c. Secured by a locking device with provisions for a padlock to prevent accidental lowering.
   7. Fastening hardware:
      a. Fasteners shall be stainless steel.
   8. Finish:
      a. As indicated on the Luminaire Schedule.

## 2.08 ACCESSORIES

A. Pole mounted convenience outlet:
   1. Where indicated, furnish a 120 Volt, GFCI protected receptacle:
      a. Integrally mounted in the pole shaft at 36 inches above the base.
   2. Complete with corrosion resistant and weatherproof cover.

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Anchoring and bracing to structures:
   1. Prepare equipment anchor setting template(s) and use to position anchors during construction of supporting structure(s).

2. Install anchors of type and material indicated on approved anchoring designs.
3. Install anchors with embedment indicated on approved anchoring designs.

## 3.03 INSTALLATION

A. Install the equipment in accordance with the accepted installation instructions and anchorage details.

B. Special techniques:
   1. Support luminaires from structural elements capable of carrying the total weight.
   2. Install luminaires plumb and square with building and wall intersections:
      a. Suspend pendant-mounted luminaries that are mounted from sloping ceilings with ball hangers, unless otherwise indicated on the Drawings.
      b. Install luminaires in machinery rooms after machines have been installed, so as to ensure no conflict with machinery, piping, or ductwork.
   3. In all cases, coordinate luminaire locations with work of other trades to prevent obstruction of light from the fixtures:
      a. Locate bottom of luminaire approximately at the bottom of ductwork, unless otherwise specified or indicated on the Drawings.
   4. Support luminaires weighing more than 25 pounds independently of the outlet box and the conduit.
   5. Provide ceiling or pendent mounted luminaires with a safety chain connecting the lens, driver, and other components to the building structure.
   6. Provide recessed luminaires with auxiliary safety supports attached directly to the building structure:
      a. The safety supports shall consist of number 12 AWG soft drawn galvanized wires.
   7. Install luminaires in accordance with the architectural reflected ceiling Drawings:
      a. Center luminaires on ceiling tiles unless otherwise indicated.
   8. Support luminaires installed in suspended grid ceilings, independently of the grid:
      a. Provide seismic restraint clips for luminaires installed in suspended grid ceilings.
   9. Provide luminaires equipped with battery backup with an additional unswitched conductor from the power source circuit designated on the Drawing. Wall switches shall be wired to switch luminaires on and off, while maintaining power to the backup batteries.

C. Luminaire poles:
   1. Set poles on anchor bolts and secured with double nuts on each bolt.
   2. Dry-pack the pole base, after the luminaire and pole has been leveled and plumbed.
   3. Bond metal poles to the plant grounding system, utilizing a ground lug connection within the pole:
      a. Route ground conductor through pier and pole base sleeve using Schedule 40 PVC conduit.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

## 3.05 FIELD QUALITY CONTROL (NOT USED)

## 3.06 ADJUSTING

A. Aim and verify exterior and outdoor luminaires alignment, during dark evening hours, as directed by the Owner or the Engineer.

## 3.07 CLEANING

A. Clean all lenses, diffusers, and reflectors.

B. Refinish luminaires' trim, poles, and support brackets, where finish has been damaged.

C. Clean LED luminaires (new and old), used during construction for construction lighting, before substantial completion.

D. Clean and re-lamp existing fluorescent and HID luminaires used during construction for construction lighting, before substantial completion.

## 3.08 SCHEDULES

A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION

## SECTION 16670

## LIGHTNING PROTECTION

### PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Design and installation of a complete lightning protection system.
   2. Materials and components for the lightning protection system.

### 1.02 REFERENCES

A. Lightning Protection Institute (LPI).
   1. 175 - Standard for the Design - Installation - Inspection of Lightning Protection Systems.
   2. 177 - Inspection Guide for Certified Systems.

B. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 780 - Standard for the Installation of Lightning Protection Systems.

C. Underwriters Laboratories, Inc. (UL):
   1. 96 - Standard for Lightning Protection Components.
   2. 96A - Standard for Installation Requirements for Lightning Protection Systems.

### 1.03 DELEGATED DESIGN (NOT USED)

### 1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Provide samples and pertinent catalog data for:
      a. Air terminals.
      b. Conductors.
      c. Connectors.
      d. Accessories.
      e. Include dimensions and materials of each component and include indication of listing in accordance with UL 96.

C. Shop Drawings:
   1. Including, but not limited to:
      a. Layout of air terminals with the respective configuration of the zone of protection.
      b. Grounding electrodes, and bonding connections to structure and other metal objects.

c. Type, size and locations for:
   1) Terminal.
   2) Electrode.
   3) Conductor.
d. Conductor routing details.
e. Connection details.
f. Termination details.
g. Applicable air terminal and other calculations.

2. Details showing installation of air terminals, conductors, and connectors.

D. Certificates:
   1. Submit written confirmation of having obtained UL Master Label or LPI certification for each lightning protection system.
   2. Photocopy of UL or LPI Installers' Certificate(s) for installation of lightning protection systems.
   3. Proof the manufacturer has been UL listed for at least 5 years.
   4. Proof the installer has been UL listed or LPI certified for at least 5 years.

E. Record Documents:
   1. Provide as specified in Section 01770 - Closeout Procedures.
   2. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.
   3. Manufacturer's installation instructions.

## 1.05 QUALITY ASSURANCE

A. Conform to the requirements of the UL or LPI and NFPA standards for lightning protection systems:
   1. Components shall be listed in accordance with UL 96.

B. Manufacturer's qualifications:
   1. Company specializing in lightning protection equipment with minimum 5 years of experience:
      a. Listed in section "Lightning Conductor, Air Terminals and Fittings" of the UL "Electrical Construction Materials Directory" for at least 5 years previous to this Contract's bid opening date.

C. Installer's qualifications:
   1. Member of the UL quality control program listed in section "Lightning Protection Installation" of the UL "Electrical Construction Materials Directory" or LPI-certified installer for installation of lightning protection systems for at least 5 years previous to this Contract's bid opening date.
      a. Lightning protection system shall meet the applicable requirements of NFPA 780 and UL 96 and 96A, or LPI 175 and 177.

D. Upon completion of installation, the lightning protection contractor to have the building lightning system physically inspected by UL or in accordance with LPI requirements:
   1. Furnish a UL Master Label or LPI Installer Certificate for the building:
      a. Application for the UL Master Label without a physical inspection by UL is unacceptable.

## 1.06 DELIVERY, STORAGE, AND HANDLING

A. Do not store or install aluminum lightning protection components in contact with concrete.

## 1.07 PROJECT OR SITE CONDITIONS (NOT USED)

## 1.08 ADMINISTRATIVE REQUIREMENTS

A. Sequencing:
   1. Pre-installation conference:
      a. Convene a pre-installation conference 2 weeks before commencing the Work of this Section, as specified in Section 01312 - Project Meetings.
   2. Coordinate Work with other trades to ensure neat, correct, and unobtrusive installation.
   3. Coordinate the Work of this Section with roofing and exterior and interior finish installations.

## 1.09 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS

## 2.01 GENERAL (NOT USED)

## 2.02 DESIGN AND PERFORMANCE CRITERIA

A. Provide the services of a lightning protection contractor to design, furnish, and install a complete lightning protection system, connected to the facility grounding system at the following structures:
   1. Caustic Soda Building.
   2. Chlorine Building.
   3. PAC Storage Tanks as specified in Section 13270 - PAC Storage and Handling System:
      a. Coordinate with PAC system supplier.

B. Lightning protection system: NFPA 780; Class I UL 96A master labeled or LPI certified system(s) protecting roof-mounted mechanical equipment, and chimneys and stacks, consisting of:
   1. Air terminals on roof(s).
   2. Bonding of structure and other metal objects.
   3. Grounding electrodes.
   4. Interconnecting conductors.

C. Connect the lightning protection system to the facility grounding electrode:
   1. Provide common ground connections as necessary to the electric service conductors.

D. Installing contractor is responsible for all costs associated with UL or LPI application/inspection of the lightning protection system, including any costs associated with re-inspection necessary to obtain the UL 96A Master Label or LPI 177 Certification.

## 2.03 MANUFACTURERS

A. One of the following or equal:
   1. Erico.
   2. Harger Lightning and Grounding.
   3. Thompson Lightning Protection, Inc.
   4. VFC, Inc.

## 2.04 MATERIALS

A. Air terminals:
   1. Material: Aluminum.
   2. Size: 3/8-inch by 18-inch minimum extending a minimum of 12 inches above the object to be protected.
   3. On flat or walkable roofs, provide air terminals with:
      a. Mushroom type blunt tip incapable of impalement if fallen upon.
      b. Spring mounted and capable of being pushed flush to the roof.
   4. Air terminals on stacks and chimneys:
      a. Protected from corrosion.
      b. Sized in accordance with UL and NFPA requirements.
      c. Lead-coated copper.
   5. Air terminal bases:
      a. Cast bronze with bolt pressure cable connections securely mounted with stainless steel screws and bolts.

B. Ground rods and below grade connectors:
   1. As specified in Section 16060 - Grounding and Bonding.

C. Ground plate: Copper.

D. Conductors:
   1. Perimeters:
      a. Aluminum.
   2. Down conductors:
      a. Copper.
   3. Sized in accordance with UL or LPI and NFPA requirements.
   4. UL listed for the application.

E. Cable fasteners:
   1. Electrolytically compatible with conductors and mounting surface:
      a. Spaced in accordance with LPI or NFPA requirements.

F. Above grade connectors:
   1. Make connections between dissimilar metals with approved bimetallic connectors.
   2. Installed by trained personnel.

3. UL listed for the application.

G. Miscellaneous materials:
   1. Copper of type and size recommended by the manufacturer of the lightning protection system.
   2. Stainless steel bolts, screws, and other threaded fasteners.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. It is the responsibility of the lightning protection subcontractor to review the electrical system design and provide any and all additional equipment and materials needed in order to construct a master labeled UL or LPI certified lightning protection system.

B. Verify that surfaces are ready to receive Work.

C. Field verify that measurements are as indicated on the Drawings.

D. Protect elements surrounding Work of this Section from damage or disfiguration.

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. In accordance with the manufacturer’s instructions unless otherwise specified in this Section.

B. Installation must be made by a LPI certified master installer or an UL certified installer.
   1. Physically connect lightning protection equipment to structural roof framing members including metal deck.
   2. Roof penetrations are not allowed:
      a. Coordinate attachment of lightning protection components by approved adhesive or clamps with Section 07540 - Thermoplastic Polyolefin (TPO) Membrane Roofing to prevent leakage.
      b. Route down conductors to edge of roof and penetrate wall for concealed down conductors.

C. Conductor installations:
   1. Install the lightning protection roof system(s) grounding and bending conductors exposed on flat roof areas and concealed at ridge roof areas.
   2. Install main downleads completely concealed and sleeved.
   3. Other than for the purpose of protecting downlead conductors from damage up to 6 feet above grade level, do not use exposed conduits to conceal the downleads on the exterior of the outside walls.
   4. Use minimum 1-inch PVC conduits to protect lightning system conductors from damage.

D. Clearances: Ensure 6-foot minimum distance required by NEC:
   1. From lightning rod conductors to non-current-carrying metal parts of electrical equipment unless they are bonded to the rods.
   2. From lightning system conductors to open conductors of communication systems.
   3. From lightning protection grounding electrodes to electrodes of other grounding systems.

E. Extend air terminals a minimum of 12 inches above object to be protected.

F. Maintain horizontal or downward coursing of main conductor and ensure that bends have at least an 8-inch radius and that no bend of a conductor forms an included angle of less than 90 degrees.

G. Grounding electrode system:
   1. Where a grounding electrode system is indicated on the Drawings, modify the installation to meet the applicable lightning protection standards.
      a. Provide additional electrodes where required.
   2. Where a grounding electrode system is not indicated on the Drawings, install grounding electrodes in accordance with the applicable UL or LPI standards.

H. Interconnection of metals:
   1. Bond metal bodies within 6 feet of the conductor to the system with approved fittings and conductor.
   2. Connections between dissimilar metals shall be made with approved bimetallic connections.
   3. Bond metal bodies of inductance located within 6 feet of a conductor or object with secondary bonds.

I. Bond isolated metallic bodies at or below the roof subject to inductance and within 6 feet of lightning protection system conductors.

J. Provide necessary common grounds between the lightning protections system and the electric service entrance wires.

K. Ensure that air terminals are installed to withstand calculated wind force due to 100 mile per hour winds or as specified in Section 01850 - Design Criteria, whichever is greater, with a 1.3 gust factor without structural damage and without damage to integrity of the lightning protection system.

## 3.04 FIELD QUALITY CONTROL

A. Provide one of the following:
   1. Services of UL to physically inspect the entire lightning protection system and issue the UL Master Label:
      a. Furnish UL Master Label as evidence that the installation has met with UL 96A code requirements.
   2. Obtain LPI system certification reports and LPI system certification.

END OF SECTION

## SECTION 16950

## FIELD ELECTRICAL ACCEPTANCE TESTS

## TABLE OF CONTENTS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section includes:
   1. Responsibilities for testing the electrical installation.
   2. Adjusting and calibration.
   3. Acceptance tests.

B. Copyright information:
   1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc. (NETA). See NETA publication ATS for details.

### 1.02 REFERENCES

A. Project references:
   1. Specification sections for the electrical equipment being tested.
   2. Electrical equipment Shop Drawings.

B. Standards:
   1. American National Standards Institute (ANSI).
   2. ASTM International (ASTM):
      a. D877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
      b. D923 - Standard Practices for Sampling Electrical Insulating Liquids.
      c. D924 - Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
      d. D971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
      e. D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
      f. D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
      g. D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
      h. D1533 - Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
      i. D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
      j. D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.
   3. Institute of Electrical and Electronics Engineers (IEEE):
      a. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
      b. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
      c. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2,300 V and Above) With High Direct Voltage.
      d. 450 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

e. 1106 - IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.
f. 1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
g. C57.13 - IEEE Standard Requirements for Instrument Transformers.
h. C57.13.1 - IEEE Guide for Field Testing of Relaying Current Transformers.
i. C57.13.3 - IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.
j. C57.104 - IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers.

4. Insulated Cable Engineer's Association (ICEA).
5. InterNational Electrical Testing Association (NETA).
   a. ATS- Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
6. International Electrotechnical Commission (IEC).
7. National Electrical Manufacturers Association (NEMA):
   a. MG1 - Motors and Generators.
8. National Fire Protection Association (NFPA):
   a. 70 - National Electrical Code (NEC).
   b. 110 - Standard for Emergency and Standby Power Systems.
9. National Institute of Standards and Technology (NIST).

## 1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Testing laboratory: Organization performing the acceptance tests.

## 1.04 DELEGATED DESIGN (NOT USED)

## 1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. Copper Ethernet test form:
   1. Cable test reports:
      a. Submit 3 copies of test reports showing the results of all tests specified in this Section:
         1) Test type.
         2) Test location.
         3) Test date.
         4) Cable number.
         5) Cable length.
         6) Certification that the cable meets or exceeds the specified standard.
      b. Furnish hard copy and electronic copy for all traces.

C. Manufacturers' testing procedures:
   1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer prior to beginning testing.

D. Test report:
   1. Include the following:
      a. Summary of Project.
      b. Description of equipment tested.
      c. Description of tests performed.
      d. Test results.
      e. Conclusions and recommendations.
      f. Completed test forms.
      g. List of test equipment used and calibration dates.
      h. LAN cable test reports.

E. Test data records:
   1. Include the following:
      a. Identification of the testing organization.
      b. Equipment identification.
      c. Nameplate data.
      d. Humidity, temperature or other conditions that may affect the results of the tests and or calibrations.
      e. Dates of inspections, tests, maintenance and or calibrations.
      f. Indication of the inspections, tests, maintenance, and or calibrations to be performed and recorded.
      g. Expected results when calibrations are to be performed.
      h. Indication of as-found and as-left results as applicable.
      i. Indication of test results outside specified tolerances.

F. Testing laboratory qualifications:
   1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:
      a. This statement will be used to determine whether the laboratory is acceptable, and shall include:
         1) Corporate history and references.
         2) Resume of individual performing test.
         3) Equipment list and test calibration data.

G. Division of responsibilities:
   1. Submit a list identifying who is responsible for performing each portion of the testing.

## 1.06 QUALITY ASSURANCE

A. Testing laboratory qualifications:
   1. May be qualified testing personnel from the electrical subcontractor’s staff or an independent testing company.
   2. NETA certification required.
   3. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

## 1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

## 1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 01850 - Design Criteria.

## 1.09 ADMINISTRATIVE REQUIREMENTS

A. General requirements:
   1. Testing of electrical equipment installed under this Contract in accordance with the manufacturer's requirements and as specified in this Section.
   2. Conduct tests in the presence of the Engineer or the Engineer's representative:
      a. Engineer will witness visual, mechanical, and electrical tests, and inspections.
   3. Testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications.

B. Responsibilities:
   1. Contractor responsibilities:
      a. Ensure that resources are made available for testing and that testing requirements are met.
   2. Electrical subcontractor responsibilities:
      a. Perform routine tests during installation.
      b. Demonstrate operation of electrical equipment.
      c. Commission the electrical installation.
      d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including, but not limited to:
         1) Providing electrical power as required.
         2) Operating of electrical equipment in conjunction with testing of other equipment.
         3) Activating and shutting down electrical circuits.
         4) Making and recording electrical measurements.
         5) Replacing blown fuses.
         6) Installing temporary jumpers.
   3. Testing laboratory responsibilities:
      a. Perform acceptance tests specified in this Section.
      b. Provide required equipment, materials, labor, and technical support during acceptance tests.

C. Sequencing:
   1. Prior to testing:
      a. At least 30 days before commencement of the acceptance tests, submit the manufacturer's complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for equipment to be tested.
   2. Perform testing in the following sequence:
      a. Perform routine tests as the equipment is installed including:
         1) Insulation-resistance tests.
         2) Continuity tests.
         3) Rotational tests.
      b. Adjusting and preliminary calibration.

c. Acceptance tests.
d. Demonstration.
e. Commissioning and plant start-up.

## 1.10 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

# PART 2 PRODUCTS (NOT USED)

# PART 3 EXECUTION

## 3.01 EXAMINATION (NOT USED)

## 3.02 PREPARATION

A. Test instrument calibration:
1. Utilize a testing laboratory with a calibration program which maintains applicable test instrumentation within rated accuracy.
   a. Calibrating standard shall be of better accuracy than that of the equipment tested.
2. Accuracy shall be traceable to the NIST in an unbroken chain.
3. Calibrate instruments in accordance with the following frequency schedule:
   a. Field instruments: 6 months maximum.
   b. Laboratory instruments: 12 months maximum.
   c. Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.
4. Dated calibration labels shall be visible on test equipment.
5. Maintain an up-to-date instrument calibration record for each test instrument:
   a. Records shall show the date and results of each calibration or test.
6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.

B. Requirements prior to testing:
1. Do not begin testing until the following conditions have been met:
   a. Instruments required are available and in proper operating condition.
   b. Required dispensable materials such as solvents, rags, and brushes are available.
   c. Equipment handling devices such as cranes, vehicles, chain falls, and other lifting equipment are available or scheduled.
   d. Instruction books, calibration curves, or other printed material to cover the electrical devices are available.
   e. Datasheets to record test results are available.

C. Engine generator tests:
1. The following individuals must be present and remain at the site during the entire field testing of the engine generator:
   a. Manufacturer’s field engineer for the voltage regulator.
   b. Manufacturer’s field engineer for the governor and governor controller.

c. Manufacturer's field engineer for the switchgear.
d. Load bank operator.
e. Electrical contractor.

## 3.03 INSTALLATION

A. Test decal:
1. Testing laboratory shall affix a test decal on the exterior of equipment or equipment enclosure of protective devices after performing electrical tests.
2. Color coded to communicate the condition of maintenance of the protective. Color scheme for condition of maintenance of overcurrent protective devices shall be:
a. White: Electrically and mechanically acceptable.
b. Yellow: Minor deficiency not affecting fault detection and operation, but minor electrical or mechanical condition exists.
3. Shall include the following information at a minimum:
a. Testing organization.
b. Project identifier.
c. Test date.
d. Technician identifier.

## 3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional Testing:
1. Also called Field Acceptance Testing.

C. Panelboards:
1. Cleaning:
a. Visually inspect panelboard for evidence of discoloration, abnormal dust accumulation, metal shards, or any other indication of overheating, wear, or other abnormal conditions prior to cleaning.
b. Clean cabinet with a brush, vacuum cleaner, or clean, dry, lint-free rags to remove any accumulation of dust, dirt, or other foreign matter. Do not use liquids, solvents or detergents when cleaning panelboards or components.
c. Avoid blowing dust into panelboards. Do not use a blower or compressed air.
d. Clean supports, terminals, and other major insulating surfaces with clean, dry, lint-free rags or soft bristled brushes.
e. Remove dust, soot, grease, moisture, and foreign material from surface of circuit breakers.
2. General:
a. Compare equipment nameplate data with the Contract Documents.
b. Check panelboard circuit schedule for accuracy.
c. Verify appropriate anchorage, required area clearances, and correct alignment.
d. Inspect overall general condition for physical damage.
1) Check for broken studs and loose or damaged wires, connector, terminations, etc.
2) Check bolts, nuts, washer, and pins for tightness.

3) Tighten or use manufacturer's replacement parts as required.

e. Inspect cabinets for signs of rust, corrosion, or deteriorating paint. Inspect cabinets for evidence of localized heat damage to the paint. Investigate sources of heat. Repair painted surfaces.

f. Check that covers are in place and fastened. Plug any open unused knockouts.

g. Inspect panelboard for moisture. Seal off any cracks or openings which have allowed moisture to enter the cabinet. Inspect component devices. Replace any components that show evidence of damage from moisture.

h. Look for any recent changes in sprinklers or other plumbing that might expose indoor panelboards to a source of liquids. Eliminate sources of water, moisture, or liquids, or provide adequate barriers to protect panelboards from sources of water, moisture, or liquids.

i. Inspect panelboards and internal components for evidence of overheating, arc spatter, sooty deposits, and tracking.

1) Investigate and correct sources of arcing or overheating.

2) Consult the panelboard manufacturer for recommendations.

j. Verify that fuse and/or circuit breaker sizes and types correspond to record drawings, if available, as well as to the circuit breakers' address for microprocessor communications packages, if equipped.

k. Set adjustable circuit breakers in accordance with engineering coordination study supplied by the Contractor.

3. Terminations, connections, and lugs:

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

1) Use of low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections:

(1) Investigate values which 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 the calibrated torque wrench method:

a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

b. Inspect terminations, connection, and lugs for alignment, physical damage, burns, corrosion, discoloration, flaking, heat damage, arcing, pitting, melting, deterioration, carbonization, cracks, chips, breaks, partial discharge, or moisture. Investigate and eliminate sources of any damage.

c. Follow manufacturer recommendations for cleaning, repairing, and replacing damaged parts.

d. Replace overheated connections. Tighten connections to proper torque levels as specified above.

4. Conductors and raceways:

a. Inspect supply conductors and terminations for overheating, discoloration, and oxidation. Investigate and correct any deficiencies.

b. Ensure the conductors are protected within their ampacities.

c. Visually check panelboard, cables, and raceways for proper bonding and grounding. Correct improper bonding and grounding.

d. Inspect conductors for discoloration, arcing, pitting, melting, flaking of insulation and/or metal parts. Repair or replace damaged components in accordance with the manufacturer's recommendations.

e. Inspect for frayed or broken wires. Replace or repair damaged components in accordance with manufacturer recommendations.
f. Inspect for frayed or broken wires. Replace or repair conductors as necessary.
g. Inspect conduits for moisture. Seal conduits which are a source of moisture and provide means to drain moisture away from the panelboard.

5. Circuit breakers:
    a. Perform visual and mechanical inspection as specified in this Section.
    b. Operate several times in order to exercise the mechanisms and the contacts, and to ensure smooth operation. Do not oil or grease parts of molded case circuit breakers.
    c. Visually check for evidence of overheating and thermal damage. Investigate and eliminate sources of overheating.
    d. Check for visual defects, chipping, cracks, breaks, burns, and deterioration. Replace damaged circuit breakers.
    e. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and anti-pump function.
    f. Inspect interchangeable trip-unit circuit breakers for tightness of trip units.
    g. Check terminals and connections for tightness as specified above.
    h. Breakers rated 100 A and higher:
        1) Perform electrical tests as specified in this Section.

D. Switchgear and switchboard:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding and required area clearances.
    d. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
    e. Verify that circuit breaker/fuse sizes and types correspond to the approved Submittals and the coordination study as well as to the circuit breakers address for microprocessor-communication packages.
    f. Verify that current and voltage transformer ratios correspond to those indicated on the Drawings.
    g. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
    h. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    i. Verify operation and sequencing of interlocking systems:
        1) Attempt closure on locked-open devices.
        2) Attempt to open locked-closed devices.
        3) Make/attempt key-exchanges in all positions.
    j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

k. Inspect insulators for evidence of physical damage or contaminated surfaces.
l. Verify correct barrier and shutter installation and operation.
m. Exercise active components.
n. Inspect mechanical indicating devices for correct operation.
o. Verify that filters are in place and/or vents are clear.
p. Perform visual and mechanical inspection of instrument transformers as specified in this Section.
q. Perform visual and mechanical inspection of surge arresters as specified in this Section.
r. Control power transformers:
    1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    2) Verify that primary and secondary fuse/circuit breaker ratings match the Submittal Drawings.
    3) Verify correct functioning of drawout disconnecting contacts grounding contacts, and interlocks.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute.
        1) Perform test in accordance with NETA ATS tables.
    c. Perform electrical tests on instrument transformers as specified in this Section.
    d. Perform ground-resistance tests:
        1) Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral and derived neutral points.
    e. Test metering devices as specified in this Section.
    f. Control power transformers:
        1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground:
            a) Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.
            b) Perform a turns-ratio test on all tap positions.
        2) Perform secondary wiring integrity test:
            a) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:
                (1) Verify correct potential at all devices.
        3) Verify correct secondary voltage by energizing primary winding with system voltage:
            a) Measure secondary voltage with the secondary wiring disconnected.
    g. Perform current injection tests on the entire current circuit of each switchgear or switchboard:
        1) Perform current tests by secondary injection with magnitudes such that a minimum current of 1.0 ampere flows in the secondary circuit:
            a) Verify the correct magnitude of current at each device in the circuit.

h. Perform system function tests.
i. Verify operation of space heaters.
j. Perform electrical tests of surge arresters as specified in this Section.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer’s published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
   c. Insulation-resistance values of bus insulation shall be in accordance with the manufacturer’s published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
      2) Investigate insulation values less than the allowable minimum.
      3) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
   d. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
   e. Instrument transformer test values shall be as specified in this Section.
   f. Meter test values shall be as specified in this Section.
   g. Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.
   h. Control power transformers:
      1) Insulation-resistance values of control power transformers shall be in accordance with the manufacturer’s published data:
         a) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
         b) Investigate insulation values less than the allowable minimum.
      2) Turns-ratio test results shall not deviate by more than 1/2 percent from either the adjacent coils or the calculated ratio.
         a) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
      3) Secondary wiring shall be as indicated on the Drawings and specified in the Specifications.
      4) Secondary voltage shall be as indicated on the Drawings.
   i. Current-injection tests shall prove current wiring is as indicated on the Drawings and specified in the Specifications.
   j. Results of system function tests shall match the Drawings and Specifications.
   k. Heaters shall be operational.
   l. Phasing checks shall prove the switchgear or switchboard phasing is correct and in accordance with the system design.
   m. Results of electrical tests on surge arresters shall be as specified in this Section.

E. Dry type transformers:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, and grounding.
      d. Verify that resilient mounts are free and that any shipping brackets have been removed.
      e. Inspect equipment for cleanliness.
      f. Inspect bolted electrical connections for high resistance using one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      g. Verify that as-left tap connections are as specified.
   2. Electrical tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground:
         1) Apply voltage in accordance with the manufacturer's published data.
            a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      c. Calculate dielectric absorption ration or polarization index.
      d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral after energization and before loading.
   3. Test values:
      a. Compare bolted connection resistance values to values of similar connections:
         1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
         1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      c. Tap connections are left as found unless otherwise specified.
      d. Minimum insulation-resistance values of transformer insulation shall be in accordance with the manufacturer's published data:
         1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
         2) Investigate insulation values less than the allowable minimum.
      e. Dielectric absorption ratio or polarization index shall not be less than 1.0.
      f. Turns-ratio results should not deviate more than 1/2 percent from either the adjacent coils or calculated ratio.
      g. Phase-to-phase and phase-to-neutral secondary voltages shall be in agreement with nameplate data.

F. Liquid-filled transformers:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.

b. Inspect physical and mechanical condition.
c. Inspect impact recorder before unloading.
d. Test dew point of tank gases, if applicable.
e. Inspect anchorage, alignment, grounding and required clearances.
f. Verify the presence of PCB content labeling.
g. Verify removal of any shipping bracing after placement.
h. Verify the bushings are clean.
i. Verify that alarm, control and trip settings on temperature and level indicators are as specified.
j. Verify operation of alarm, control, and trip circuits from temperature and level indicators, pressure relief device, gas accumulator, and fault pressure relay, if applicable.
k. Verify that cooling fans operate correctly and that fan motors have correct overcurrent protection.
l. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        a) Refer to the manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.
m. Verify correct liquid level in tanks and bushings.
n. Verify valves are in the correct operating position.
o. Verify that positive pressure is maintained on gas-blanketed transformers.
p. Perform inspections and mechanical tests as recommended by the manufacturer.
q. Test load tap-changer in accordance with NETA ATS requirements.
r. Verify presence of transformer surge arresters.
s. Verify de-energized tap-changer position is left as specified.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground:
        1) Apply voltage in accordance with the manufacturer’s published data:
            a) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
        2) Calculate polarization index.
    c. Perform turns ratio tests at all tap positions.
    d. Perform insulation power-factor or dissipation-factor tests on windings in accordance with the test equipment manufacturer’s published data.
    e. Perform power-factor or dissipation-factor tests on each bushing equipped with a power-factor/capacitance tap:
        1) In the absence of a power-factor/capacitance tap, perform hot-collar tests.
        2) Perform tests in accordance with the test equipment manufacturer’s published data.
    f. Perform excitation-current tests in accordance with the test equipment manufacturer’s published data.
    g. Perform sweep frequency response analysis tests.

h. Measure the resistance of each primary winding in each no-load tap changer position. Measure the resistance of each secondary winding in each no-load tap changer position.
i. Remove a sample of insulating liquid in accordance with ASTM D923 and test in accordance with the following standards:
    1) Dielectric breakdown voltage: ASTM D877 or ASTM D1816.
    2) Acid neutralization number: ASTM D974.
    3) Interfacial tension: ASTM D971.
    4) Color: ASTM D1500.
    5) Visual condition: ASTM D1524.
    6) Water in insulating fluids: ASTM D1533.
j. Remove a sample of insulating liquid in accordance with ASTM D924. Sample shall be tested for the following:
    1) Dissolved-gas analysis: IEEE C57.104 or ASTM D3612.
k. Test instrument transformers as specified in this Section.
l. Test surge arresters as specified in this Section, if applicable.
m. Test transformer neutral grounding impedance device, if applicable.
n. Verify operation of cubicle or air terminal compartment space heaters.

3. Test values:
    a. Alarm control and trip circuits from temperature and level indicators, as well as pressure relief device and fault pressure relay, shall operate within the manufacturer’s recommendations for their specified settings.
    b. Cooling fans and pumps shall operate.
    c. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    d. Bolt-torque levels shall be in accordance with the manufacturer’s published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
    e. Liquid levels in the transformer tanks and bushings shall be within indicated tolerances.
    f. Positive pressure shall be indicated on pressure gauge for gas-blanketed transformers.
    g. Minimum insulation-resistance values of transformer insulation shall be in accordance with the manufacturer’s published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
        2) Investigate insulation values less than the allowable minimum.
    h. Polarization index shall be greater than 1.0:
        1) Compare to any previous values.
    i. Turns-ratio test result shall not deviate by more than 1/2 percent from either the adjacent coils or the calculated ratio.
    j. Maximum winding insulation power-factor/dissipation-factor values shall be in accordance with the manufacturer’s published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
    k. Investigate bushing power-factor values that vary from nameplate values by more than 150 percent. Investigate bushing capacitance values that

vary from nameplate values by more than 5 percent. Investigate bushing hot-collar test values that exceed 0.1 watts.

l. Typical excitation-current test data pattern for a 3-legged core transformer is 2 similar current readings and 1 lower current reading.
m. Sweep frequency response analysis test results shall be comparable to previously obtained results.
n. Consult the manufacturer if winding-resistance test values vary by more than 2 percent from factory test values or between adjacent phases.
o. Investigate leakage reactance per phase test results that deviate from the average of the 3 readings by more than 3 percent. 3 phase equivalent test results serve as a benchmark for future tests.
p. Core insulation values shall be comparable to previously obtained results but not be less than 1.0 megohm at 500 VDC.
q. Investigate the presence of oxygen in the nitrogen gas blanket.
r. Insulating liquid values shall be in accordance with NETA ATS tables.
s. Evaluate results of dissolved-gas analysis in accordance with IEEE C57.104.
t. Results of electrical tests on instrument transformers shall be as specified in this Section.
u. Results of surge arrester tests shall be as specified in this Section.
v. Compare grounding impedance device results to the manufacturer's published data.
w. Heaters shall be operational.

G. Low voltage cables, 600 volt maximum:
1. Visual and mechanical inspection:
    a. Compare cable data with the Drawings and Specifications.
    b. Inspect exposed sections of cable for physical damage and correct connection as indicated on the Drawings.
    c. Inspect bolted electrical connections for high resistance by one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    d. Inspect compression applied connectors for correct cable match and indentation.
    e. Inspect for correct identification and arrangement.
    f. Inspect cable jacket insulation and condition.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation resistance test on each conductor sized #8 AWG or larger with respect to ground and adjacent conductors:
        1) Applied potential shall be 500 volts DC for 300-volt rated cable and 1,000 volts DC for 600-volt rated cable.
        2) Test duration shall be 1 minute.
    c. Perform continuity tests on power and control conductors to ensure correct cable connection.
    d. Verify uniform resistance of parallel conductors.

3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Insulation-resistance values shall be in accordance with the manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
        2) Investigate values of insulation-resistance less than the allowable minimum.
    c. Cable shall exhibit continuity.
    d. Deviations in resistance between parallel conductors shall be investigated.

H. Medium voltage cables:
1. Visual and mechanical inspection:
    a. Compare cable data with the Contract Documents.
    b. Inspect exposed sections of cables for physical damage.
    c. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    d. Inspect compression-applied connectors for correct cable match and indentation.
    e. Inspect shield grounding, cable support, and terminations.
    f. Verify the visible bends meet or exceed ICEA and the manufacturer's published minimum allowable bending radius.
    g. If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.
    h. Inspect for correct identification and arrangements.
    i. Inspect jacket insulation and condition.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with low-resistance ohmmeter.
    b. Perform an insulation-resistance test individually on each conductor with all other conductors and shields grounded:
        1) Apply voltage in accordance with the manufacturer's published data:
            a) Refer to NETA ATS tables in the absence of the manufacturer's published data.
    c. Perform shield-continuity test on each power cable.
    d. Perform cable and time domain reflectometer (TDR) measurements on each conductor.
    e. In accordance with ICEA, IEC, IEEE, and other power cable consensus standards, testing can be performed by means of direct current, power

frequency alternating current, very low frequency alternating current, or damped alternating current.

1) These sources may be used to perform insulation-resistance tests, and baseline diagnostic tests such as partial discharge analysis, and power factor or power dissipation factor.
2) Selection shall be made after an evaluation of the available test methods and a review of the installed cable system.
3) Some of available test methods are as follows:
   a) Dielectric withstand:
      (1) Direct current dielectric withstand voltage.
      (2) Very low frequency dielectric withstand voltage.
      (3) Power frequency dielectric withstand voltage.
      (4) Damped alternating current voltage.
   b) Baseline diagnostic tests:
      (1) Power factor/dissipation factor (tan delta):
         (a) Power frequency.
         (b) Very low frequency.
      (2) Direct current insulation-resistance.
      (3) Partial discharge:
         (a) Online (50/60 hertz).
         (b) Offline:
            - Power frequency.
            - Very low frequency.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Minimum bend radius to which insulated cables may be bent for permanent training shall be in accordance with NETA ATS tables.
   d. Insulation-resistance values shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      2) Investigate values of insulation-resistance less than the allowable minimum.
   e. Shielding shall exhibit continuity:
      1) Investigate resistance values in excess of 10 ohms per 1,000 feet of cable.
   f. If no evidence of distress of insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
   g. Based on the test methodology chosen, refer to the applicable standards or manufacturer's literature for acceptable values.

I. Low voltage molded case and insulated case circuit breakers:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage and alignment.
      d. Verify the unit is clean.
      e. Operate the circuit breaker to ensure smooth operation.
      f. Inspect bolted electrical connections for high resistance by one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      g. Perform adjustments for final protective device settings in accordance with the coordination study.
   2. Electrical tests:
      a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      b. For breakers 100 A and higher:
         1) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:
            a) Apply voltage in accordance with the manufacturer's published data.
            b) Refer to NETA ATS tables in the absence of the manufacturer's published data.
         2) Perform a contact/pole-resistance test.
         3) Determine long-time pickup and delay by primary current injection.
         4) Determine short-time pickup and delay by primary current injection.
         5) Determine ground-fault pickup and delay by primary current injection.
         6) Determine instantaneous pickup value by primary current injection.
         7) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with the manufacturer's published data.
         8) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function and trip unit battery condition:
            a) Reset trip logs and indicators.
         9) Verify operation of charging mechanism.
   3. Test values:
      a. Compare bolted connection resistance values to values of similar connections:
         1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
         1) Refer to NETA ATS tables in the absence of the manufacturer's published data.

c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
   1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   2) Investigate values of insulation-resistance less than the allowable minimum.
d. Microhm or DC millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
   1) If the manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
e. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current characteristic tolerance band including adjustment factors:
   1) If the manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
f. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current tolerance band.
g. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed the manufacturer's published time-current tolerance band.
h. Instantaneous pickup values shall be as specified and within the manufacturer's published tolerances:
   1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
i. Pickup values and trip characteristics shall be within the manufacturer's published tolerances.
j. Determine energy reducing maintenance switch pickup value by primary current injection.
k. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
l. Charging mechanism shall operate in accordance with the manufacturer's published data.

J. Instrument transformers - voltage transformers:
1. Visual and mechanical inspection:
   a. Compare equipment nameplate data with the Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Verify correct connection of transformers with system requirements.
   d. Verify that adequate clearances exist between primary and secondary circuit wiring.
   e. Verify the unit is clean.
   f. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
         a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
   g. Verify that required grounding and connections provide contact.
   h. Verify correct primary and secondary fuse sizes for voltage transformers.

i. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
j. Perform as-left tests.

2. Electrical tests - voltage transformers:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform insulation-resistance tests winding-to-winding and winding-to-ground:
      1) Test voltage shall be applied for 1 minute in accordance with NETA ATS requirements.
      2) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
   c. Perform a polarity test on each voltage transformer to verify the polarity marks on $H_1$- $X_1$ relationship as applicable.
   d. Perform a turns ratio test on all tap positions.
   e. Measure voltage circuit burdens at transformer terminals.
   f. Perform a dielectric withstand test on the primary windings with the secondary windings grounded:
      1) Dielectric voltage shall be in accordance with NETA ATS tables.
      2) Apply the test voltage for 1 minute.
   g. Perform power-factor or dissipation-factor tests in accordance with the test equipment manufacturer's published data.
   h. Verify that voltage transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
      1) That grounding point should be located as specified by the Engineer in the Contract Documents.
3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Insulation-resistance values of instrument transformers shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   d. Polarity results shall agree with transformer markings.
   e. Ratio errors shall be in accordance with IEEE C57.13.
   f. Measured burdens shall be compared to instrument transformer ratings.
   g. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
   h. Power-factor or dissipation-factor values shall be compared to the manufacturer's published data:
      1) In the absence of the manufacturer's published data, use the test equipment manufacturer's published data.
   i. Test results shall indicate that the circuits have only 1 grounding point.

K. Metering devices, microprocessor based:
1. Visual and mechanical inspection:
   a. Compare equipment nameplate data with the Contract Documents.
   b. Inspect meters and cases for physical damage.
   c. Clean front panel.
   d. Verify tightness of electrical connections.
   e. Record the following:
      1) Model number.
      2) Serial number.
      3) Firmware revision.
      4) Software revision.
      5) Rated control voltage.
   f. Verify operation of display and indicating devices.
   g. Record passwords.
   h. Verify the unit is grounded in accordance with the manufacturer's instructions.
   i. Set required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.
2. Electrical tests:
   a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
   b. Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital and analog.
   c. After initial system energization, confirm measurements and indications are consistent with loads present.
3. Test values:
   a. Nameplate data shall match the Contract Documents.
   b. Tightness of electrical connections shall ensure a low resistance connection.
   c. Display and indicating devices shall operate in accordance with the manufacturer's published data.
   d. Measurement and indication of applied voltages and currents shall be within the manufacturer's published tolerances for accuracy.
   e. Auxiliary input/output features shall operate in accordance with the settings and the manufacturer's published data.
   f. Measure and indications shall be consistent with energized system loads.

L. Grounding systems:
1. Visual and mechanical inspection:
   a. Inspect ground system for compliance with the Contract Documents and the NEC.
   b. Inspect physical and mechanical condition.
   c. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
         a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
   d. Inspect anchorage.

2. Electrical tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform fall of potential test or alternative test in accordance with IEEE 81 on the main grounding electrode or system.
   c. Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, the system neutral and any derived neutral points.
3. Test values:
   a. Grounding system electrical and mechanical connections shall be free of corrosion.
   b. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   c. Bolt-torque levels shall be in accordance with the manufacturer’s published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
   d. Resistance between the main grounding electrode and ground shall be as specified in Section 16060 - Grounding and Bonding.
   e. Investigate point-to-point resistance values that exceed 0.5 ohm.

M. Rotating machinery, AC induction motors and generators:
1. Visual and mechanical inspection:
   a. Compare equipment nameplate information with the Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, and grounding.
   d. Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging.
   e. Inspect bolted electrical connections for high resistance using one or more of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
         a) Refer to the manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.
   f. Manually rotate the rotor and check for problems with the bearings or shaft.
   g. Rotating equipment:
      1) Operate at rated design load conditions.
      2) Confirm that equipment is properly assembled.
      3) Confirm the equipment moves or rotates in the proper direction.
      4) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
      5) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
   h. Verify correct application of appropriate lubrication and lubrication systems.
   i. Verify that resistance temperature detector (RTD) circuits conform to that indicated on the Drawings.

2. Electrical tests - AC induction:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform insulation-resistance test in accordance with IEEE 43:
      1) On motors 200 horsepower and smaller, test duration shall be 1 minute. Calculate dielectric absorption ratio for 60/30-second periods.
      2) On motors larger than 200 horsepower, test duration shall be 10 minutes. Calculate polarization index.
   c. On machines rated at 2,300 volts and greater, perform dielectric withstand voltage tests in accordance with:
      1) IEEE 95 for DC dielectric withstand voltage tests.
      2) NEMA MG1 for AC dielectric withstand voltage tests.
   d. Perform phase-to-phase stator resistance test on machines rated at 2,300 volts and greater.
   e. Perform insulation-resistance test on insulated bearings in accordance with the manufacturer's published data.
   f. Test surge protection devices as specified in this Section.
   g. Test motor starter as specified in this Section.
   h. Perform resistance tests on resistance temperature detector (RTD) circuits.
   i. Verify operation of motor space heater, if applicable.
3. Test values:
   a. Inspection:
      1) Air baffles shall be clean and installed in accordance with the manufacturer's published data.
      2) Filter media shall be clean and installed in accordance with the manufacturer's published data.
      3) Cooling fans shall operate.
      4) Slip ring alignment shall be within the manufacturer's published tolerances.
      5) Brush alignment shall be within the manufacturer's published tolerances.
      6) Brush rigging shall be within the manufacturer's published tolerances.
   b. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   c. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   d. Airgap spacing and machine alignment shall be in accordance with the manufacturer's published data.
   e. Recommended minimum insulation-resistance ($IR_{1\ min}$) test results in megohms shall be in accordance with NETA ATS tables.
      1) Polarization index value shall not be less than 2.0.
      2) Dielectric absorption ratio shall not be less than 1.4.
   f. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

g. Investigate phase-to-phase stator resistance values that deviate by more than 5 percent.
h. Power factor or dissipation factor values shall be compared to the manufacturer's published data:
    1) In the absence of the manufacturer's published data, compare values of similar machines.
i. Tip-up values shall indicate no significant increase in power factor.
j. If no evidence of distress, insulation failure, or waveform nesting is observed by the end of the total time of voltage application during the surge comparison test, the test specimen is considered to have passed the test.
k. Bearing insulation-resistance measurements shall be within manufacturer's published tolerances:
    1) In the absence of the manufacturer's published data, compare values of similar machines.
l. Test results of surge protection devices shall be as specified in this Section.
m. Test results of motor starter equipment shall be as specified in this Section.
n. RTD circuits shall conform to the design intent and machine protection device manufacturer's published data.
o. Heaters shall be operational.
p. Vibration amplitudes of the uncoupled and unloaded machine shall be in accordance with the manufacturer's published data:
    1) In the absence of the manufacturer's published data, vibration amplitudes shall not exceed values in NETA ATS tables.
    2) If values exceed those in the NETA ATS tables, perform a complete vibration analysis.

N. Motor starters, low voltage:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate information with the Contract Documents.
    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 is in accordance with the manufacturer's published data.
    f. Motor-running protection:
        1) Verify overload element rating/motor protection settings are 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 following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    h. Lubrication requirements:
        1) Verify appropriate lubrication on moving current-carrying parts.
        2) Verify appropriate lubrication on moving and sliding surfaces.

2. Electrical tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the starter closed, and across each open pole for 1 minute:
      1) Test voltage shall be in accordance with the manufacturer's published data.
      2) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Test motor protection devices in accordance with the manufacturer's published data.
   d. Test circuit breakers as specified in this Section.
   e. Perform operational tests by initiating control devices.
3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Insulation-resistance values shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      2) Investigate values of insulation-resistance less than the allowable minimum.
   d. Motor protection parameters shall be in accordance with the manufacturer's published data.
   e. Circuit breaker test results shall as be specified in this Section.
   f. Control devices shall perform in accordance with system design requirements.

O. Motor control centers, low voltage:
1. Visual and mechanical inspection:
   a. Compare equipment nameplate data with the Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding and required clearances.
   d. Verify the unit is clean and shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
   e. Verify that circuit breaker/fuse sizes and types correspond to the approved Submittals and the coordination study.
   f. Verify that current and voltage transformer ratios correspond to those indicated on the Drawings.
   g. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
   h. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
   a) Refer to the manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.

i. Verify operation and sequencing of interlocking systems:
   1) Attempt closure on locked-open devices.
   2) Attempt to open locked-closed devices.
   3) Make/attempt key-exchanges in all positions.

j. Lubrication requirements:
   1) Verify appropriate lubrication on moving current-carrying parts.
   2) Verify appropriate lubrication on moving and sliding surfaces.

k. Inspect insulators for evidence of physical damage or contaminated surfaces.

l. Verify correct barrier and shutter installation and operation.

m. Exercise active components.

n. Inspect indicating devices for correct operation.

o. Verify that filters are in place and/or vents are clear.

p. Perform visual and mechanical inspection of instrument transformers as specified in this Section.

q. Perform visual and mechanical inspection of surge arresters as specified in this Section.

r. Inspect control power transformers:
   1) Inspect for physical damage, cracked insulation, broken leads, and tightness of connections, defective wiring, and overall general condition.
   2) Verify that primary and secondary fuse/circuit breaker ratings match the Submittal Drawings.
   3) Verify correction functioning of grounding contacts.

s. Perform visual and mechanical inspection of motor control center components as specified in this Section.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute:
   1) Perform test in accordance with NETA ATS tables.

c. Perform a dielectric withstand test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with the manufacturer’s published data or NETA ATS tables. Apply the test voltage for 1 minute.

d. Perform ground-resistance tests:
   1) Perform point-to-point tests to determine the resistance between the main grounding system and major electrical equipment frames, system neutral and derived neutral points.

e. Control power transformers:
   1) Perform insulation-resistance tests, winding-to-winding and winding-to-ground:
      a) Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.

2) Perform secondary wiring integrity test:
   a) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:
      (1) Verify correct potential at all devices.
3) Verify correct secondary voltage by energizing primary winding with system voltage:
   a) Measure secondary voltage with the secondary wiring disconnected.

f. Verify operation of space heaters.
g. Perform electrical tests of motor control center components as specified in this Section.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer’s published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
   c. Insulation-resistance values for bus and control power transformers shall be in accordance with the manufacturer’s published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
      2) Investigate insulation values less than the allowable minimum.
      3) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
   d. Bus insulation shall withstand the over potential test voltage applied.
   e. Instrument transformer test values shall be as specified in this Section.
   f. Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.
   g. Meter accuracy shall be in accordance with the manufacturer’s published data.
   h. Control power transformers:
      1) Insulation-resistance values of control power transformers shall be in accordance with the manufacturer’s published data:
         a) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
         b) Investigate insulation values less than the allowable minimum.
         c) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
      2) Secondary wiring shall be as indicated on the Drawings and specified in the Specifications.
      3) Secondary voltage shall be as indicated on the Drawings.
   i. Heaters shall be operational.
   j. Test values for motor control center components shall be as specified in this Section.

P. Variable frequency drive systems:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.

b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Motor running protection:
    1) Verify drive overcurrent setpoints are correct for their application.
    2) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.
    3) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.
h. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
i. Verify correct fuse sizing in accordance with the manufacturer's published data.
j. Perform visual and mechanical inspection of input circuit breaker as specified in this Section.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with low resistance ohmmeter.
    b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
    c. Test for the following parameters in accordance with relay calibration procedures specified in NETA ATS, or as recommended by the manufacturer:
        1) Input phase loss protection.
        2) Input overvoltage protection.
        3) Output phase rotation.
        4) Overtemperature protection.
        5) Direct current overvoltage protection.
        6) Overfrequency protection.
        7) Drive overload protection.
        8) Fault alarm outputs.
    d. Harmonic distortion measurements for both voltage and current is within the specification limits at the installed site.
    e. Peak voltage at the motor terminations is less than 90 percent of the motor insulation dielectric withstand level.
    f. Perform continuity tests on bonding conductors as specified in accordance with NETA ATS.
    g. Perform start-up of drive in accordance with the manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.

h. Perform operational tests by initiating control devices:
   1) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
   2) Verify operation of drive from remote start/stop and speed control signals.
i. Perform electrical tests of input circuit breaker as specified in this Section.
j. Measure fuse resistance.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Overload test trip times at 300 percent of overload element rating shall be in accordance with the manufacturer's published time-current curve.
   d. Test values for input circuit breaker shall be as specified in this Section.
   e. Relay calibration results shall be as specified in this Section.
   f. Continuity of bonding conductors shall be in accordance with NETA ATS.
   g. Control devices shall perform in accordance with system requirements.
   h. Operational tests shall conform to system design requirements.
   i. Investigate fuse resistance values that deviate from each other by more than 15 percent.

Q. Single engine generator:
1. Visual and mechanical inspection:
   a. Compare equipment nameplate data with the Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, and grounding.
   d. Verify the unit is clean.
2. Electrical and mechanical tests:
   a. Perform insulation-resistance tests in accordance with IEEE 43:
      1) Machines larger than 150 kilowatts: Test duration shall be 10 minutes. Calculate polarization index.
      2) Machines 150 kilowatts and less: Test duration shall be 1 minute. Calculate the dielectric-absorption rate.
   b. Test protective relay devices as specified in this Section.
   c. Verify phase rotation, phasing, and synchronized operation as required by the application.
   d. Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
   e. Conduct performance test in accordance with NFPA 110.
   f. Verify correct functioning of governor and regulator.
   g. Load bank testing:
      1) Provide a resistive load bank to test the operation of the engine generator.
      2) Load bank shall be capable of loading the engine generator to its full nameplate kilowatt rating at unity power factor.

3) Load steps shall simulate the plant load steps used in sizing the engine generator.
4) Test run at full nameplate kilowatt rating for a minimum of 4 hours:
    a) Record at 10-minute intervals:
        (1) Voltage.
        (2) Frequency.
        (3) Current.
        (4) Power factor.
        (5) Engine oil pressure.
        (6) Engine oil temperature.
        (7) Air inlet temperature.
        (8) Radiator discharge temperature.
        (9) Engine coolant temperature.
        (10) Vibration levels at each main bearing cap.

3. Test values:
    a. Anchorage, alignment, and grounding should be in accordance with the manufacturer's published data and system design.
    b. Dielectric absorption ratio or polarization index shall be compared to previously obtained results and should not be less than 1.0. Recommended minimum insulation ($IR_{1\ min}$) test results in megohms shall be corrected to 40 degrees Celsius and read as follows:
        1) $IR_{1\ min}$ equals kilovolt + 1 for most windings made before 1970, all field windings, and others not described below.
            a) Kilovolt is the rated machine terminal-to-terminal voltage in rms kilovolt.
        2) $IR_{1\ min}$ equals 100 megohms for most DC armature and AC windings built after 1970 (form-wound coils).
        3) $IR_{1\ min}$ equals 5 megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kilovolt.
            a) Dielectric withstand voltage and surge comparison tests shall not be performed on machines having lower values than those indicated above.
    c. Polarization index value shall not be less than 2.0.
    d. Dielectric absorption ratio shall be greater than 1.0.
    e. Protective relay device test results shall be as specified in this Section.
    f. Phase rotation, phasing, and synchronizing shall be in accordance with system design requirements.
    g. Low oil pressure, over temperature, over speed, and other protection features shall operate in accordance with the manufacturer's published data and system design requirements.
    h. Vibration levels shall be in accordance with the manufacturer's published data and shall be compared to baseline data.
    i. Performance tests shall conform to the manufacturer's published data and NFPA 110.
    j. Governor and voltage regulator shall operate in accordance with the manufacturer's published data and system design requirements:
        1) Steady state voltage regulation shall be within 0.5 percent of set point.
        2) Output voltage of the generator shall not fall below 10 percent of the power system nominal rating for more than 5 seconds.
        3) Output voltage of the generators shall not exceed the power system nominal rating at any time.

4) Steady state frequency regulation shall be within 59.5 hertz to 60.5 hertz.
5) Frequency variations shall not exceed 2 hertz from 60 hertz for more than 2 seconds.

R. Uninterruptible power systems:
1. Testing and settings shall be conducted by the UPS manufacturer's field engineer. Test the complete operation of:
   a. Static transfer system.
   b. Static bypass system.
   c. Maintenance bypass system.
2. Visual and mechanical inspection:
   a. Compare equipment nameplate data with the Contract Documents.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding, and required clearances.
   d. Verify that fuse sizes and types correspond to that indicated on the Drawings.
   e. Verify the unit is clean.
   f. Test electrical and mechanical interlock systems for correct operation and sequencing.
   g. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
         a) Refer to the manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
   h. Verify operation of forced ventilation.
   i. Verify that filters are in place and/or vents are clear.
3. Electrical tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Test static transfer from inverter to bypass and back. Use normal load, if possible.
   c. Set free running frequency of oscillator.
   d. Test DC undervoltage trip level on inverter input breaker. Set according to manufacturer's published data.
   e. Test alarm circuits.
   f. Verify synchronizing indicators for static switch and bypass switches.
   g. Perform electrical tests for:
      1) UPS system breakers as specified in this Section.
      2) UPS system automatic transfer switches as specified in this Section.
      3) UPS system batteries as specified in this Section.
      4) UPS rotating machinery as specified in this Section.
4. Test values:
   a. Electrical and mechanical interlock systems shall operate in accordance with system design requirements.
   b. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Bolt-torque levels shall be in accordance with the manufacturer’s published data:
    1) Refer to NETA ATS tables in the absence of the manufacturer’s published data.
d. Static transfer shall function in accordance with the manufacturer’s published data.
e. Oscillator free running frequency shall be within the manufacturer’s published tolerances.
f. Direct current undervoltage shall trip inverter input breaker.
g. Alarm circuits shall operate in accordance with design requirements.
h. Synchronizing indicators shall operate in accordance with design requirements.
i. Breaker performance shall be as specified in this Section.
j. Automatic transfer switch performance shall be as specified in this Section.
k. Battery test results shall be as specified in this Section.
l. Rotating machinery performance shall be as specified in this Section.

S. Automatic transfer switches:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify the unit is clean.
    e. Lubrication requirements:
        1) Verify appropriate lubrication on moving current-carrying parts.
        2) Verify appropriate lubrication on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench:
            a) Refer to the manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.
    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform a contact/pole-resistance test.
    c. Verify settings and operation of control devices.
    d. Calibrate and set relays and timers as specified in this Section.
    e. Verify phase rotation, phasing, and synchronized operation as required by the application.
    f. Perform automatic transfer tests:
        1) Simulate loss of normal power.
        2) Return to normal power.
        3) Simulate loss of emergency power.

4) Simulate all forms of single-phase conditions.

g. Verify correct operation and timing of the following functions:
   1) Normal source voltage-sensing and frequency-sensing relays.
   2) Engine start sequence.
   3) Time delay upon transfer.
   4) Alternate source voltage-sensing and frequency-sensing relays.
   5) Automatic transfer operation.
   6) Interlocks and limit switch function.
   7) Time delay and retransfer upon normal power restoration.
   8) Engine cool down and shutdown feature.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
   c. Insulation resistance values of transfer switches shall be in accordance with the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of the manufacturer's published data.
      2) Values of insulation resistance less than this table or the manufacturer's recommendations shall be investigated.
   d. Microhm or DC millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
      1) If the manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
   e. Control devices shall operate in accordance with the manufacturer's published data.
   f. Relay test results shall be as specified in this Section.
   g. Phase rotation, phasing, and synchronization shall be as specified in the system design specifications.
   h. Operation and timing shall be in accordance with the manufacturer's and system design requirements.

T. Fiber-optic cables:
   1. Visual and mechanical inspection:
      a. Compare cable, connector, and splice data with the Contract Documents.
      b. Inspect cable and connections for physical and mechanical damage.
      c. Verify that connectors and splices are correctly installed.
   2. Optical tests:
      a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer (OTDR):
         1) OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable.
         2) Adjust OTDR pulse width settings to a maximum setting of 1/1,000th of the cable length or 10 nanoseconds.

b. Perform connector and splice integrity test using an optical time domain reflectometer.
c. Perform cable attenuation loss measurement with an optical power loss test set:
    1) Perform attenuation tests with an optical loss test set capable and calibrated to show anomalies of 0.1 dB as a minimum.
    2) Test multimode fibers at 850 nanometer and 1,300 nanometer.
    3) Test single mode fibers at 1,310 nanometer and 1,550 nanometer.
d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set:
    1) At the conclusion of all outdoor splices at 1 location, and before they are enclosed and sealed, splices shall be tested with OTDR at the optimal wavelengths (850 and 1,300 for multimode, 1,310 and 1,550 for single mode), in both directions. Splices shall be tested for integrity as well as attenuation.
e. Perform fiber links integrity and attenuation tests using each link shall be an OTDR and an optical loss test set:
    1) OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850 nanometer, and 1,300 nanometer for multimode fibers.
    2) Optical loss testing shall be done with handheld test sets in 1 direction at the 2 optimal wavelengths for the appropriate fiber type. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.

3. Test values:
    a. Cable and connections shall not have been subjected to physical or mechanical damage.
    b. Connectors and splices shall be installed in accordance with industry standards.
    c. Optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
    d. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer’s recommendations when no local site specifications are available.
    e. Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filed with the records of the respective cable runs.

U. Copper Ethernet cable installation testing:
1. Pre-installation:
    a. Immediately prior to installation, verify that cable to be installed matches that which was submitted.
    b. Verify that no damage has been done to the cable during shipping or handling.
    c. Inspect cable for physical and mechanical damage.
    d. Engineer shall be notified if a cable fails to meet inspection and the cable shall not be installed unless otherwise directed by the Engineer.
2. Post-installation:
    a. Prior to copper Ethernet cable termination, perform cable end-to-end continuity validation testing on installed cables, conductor pairs and cable

shields using toner and probe kit. Any cable that fails testing shall be removed and replaced.
b. Inspect equipment outlet connectors for damage and ensure connectors hold tightly in field device ports.
3. Test equipment:
a. Certification equipment used for the testing shall be capable of verifying twisted pair cable installation with end-to-end continuity testing.
b. Use only test cords and adapters that are qualified by the test equipment manufacturer for channel or link test configuration.
c. Manufacturers: The following or equal:
1) Fluke Networks, IntelliTone Pro 200 Toner and Probe Kit, MT-8200-60-KIT.
d. Permanent link testing requirements: As specified in Section 17950 - Commissioning for Instrumentation and Controls.

## 3.05 FIELD QUALITY CONTROL (NOT USED)

## 3.06 ADJUSTING (NOT USED)

## 3.07 CLEANING

A. Dispose of testing expendables.

B. Vacuum cabinets.

C. Sweep clean surrounding areas.

END OF SECTION

SECTION 16990A

CONDUIT SCHEDULE
AREA 01

# PART 1 GENERAL

## 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 3/CS#16: 3 conductor, 16 gauge, twisted shielded triplet.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. */FO: Fiber optic (* indicates strand count).
   5. CAT6: Category 6 Ethernet cable.
   6. PULL: Pull Rope.

# PART 2 PRODUCTS

Not Used.

# PART 3 EXECUTION

## 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

| | |
|---|---|
| ENGINEER | SKB |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-01-091 | 02E03 | 2" | 1 | PULL | ROPE | | | | FR: SWBD-APF<br>TO: XFMR-APF<br>1 PULL >> SPARE | |
| C-01-501 | 01E02<br>02E03 | 2" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: CL2-ALARM STROBE<br>TO: PB-15<br>4 #14 >> CL2-ALARM STROBE CONTROL | C-01-502 |
| C-01-502 | 02E01 | 2" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PB-15<br>TO: PB-14<br>4 #14 >> CL2-ALARM STROBE CONTROL | C-01-503<br><br>C-01-501 |
| C-01-503 | 02E01 | 2" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PB-14<br>TO: PB-13<br>4 #14 >> CL2-ALARM STROBE CONTROL | C-01-504<br><br>C-01-502 |
| C-01-504 | 02E01<br>63E05 | 2" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PB-13<br>TO: CLIP PANEL<br>4 #14 >> CL2-ALARM STROBE CONTROL | <br><br>C-01-503 |
| C-01-601 | 01E03 | 1" | 3 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6001<br>TO: PB #2A<br>3 #14 >> LSH-6001 CONTROL | C-01-602 |
| C-01-602 | 01E03 | 1" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6002<br>TO: PB #3A<br>3 #14 >> LSH-6001 CONTROL<br>3 #14 >> LSH-6002 CONTROL | C-01-603<br><br>C-01-601 |
| C-01-603 | 01E03 | 1" | 9 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6003<br>TO: PB #4A<br>3 #14 >> LSH-6001 CONTROL<br>3 #14 >> LSH-6002 CONTROL<br>3 #14 >> LSH-6003 CONTROL | C-01-604<br><br>C-01-602<br>C-01-602 |
| C-01-604 | 01E03 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6004<br>TO: PB #5A<br>3 #14 >> LSH-6001 CONTROL<br>3 #14 >> LSH-6002 CONTROL<br>3 #14 >> LSH-6003 CONTROL<br>3 #14 >> LSH-6004 CONTROL | C-01-605<br><br>C-01-603<br>C-01-603<br>C-01-603 |
| C-01-605 | 01E03 | 2" | 33 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6005<br>TO: PB-13<br>3 #14 >> LSH-6001 CONTROL<br>3 #14 >> LSH-6002 CONTROL<br>3 #14 >> LSH-6003 CONTROL<br>3 #14 >> LSH-6004 CONTROL<br>3 #14 >> LSH-6005 CONTROL<br>3 #14 >> LSH-6006 CONTROL<br>3 #14 >> LSH-6007 CONTROL<br>3 #14 >> LSH-6008 CONTROL<br>3 #14 >> LSH-6009 CONTROL<br>3 #14 >> LSH-6010 CONTROL<br>3 #14 >> LSH-6011 CONTROL | C-01-615<br><br>C-01-604<br>C-01-604<br>C-01-604<br>C-01-604<br><br>C-01-606<br>C-01-606<br>C-01-606<br>C-01-609<br>C-01-609<br>C-01-609 |
| C-01-606 | 01E03 | 1" | 9 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6006<br>TO: PB #5A<br>3 #14 >> LSH-6006 CONTROL<br>3 #14 >> LSH-6007 CONTROL<br>3 #14 >> LSH-6008 CONTROL | C-01-605<br><br><br>C-01-607<br>C-01-607 |
| C-01-607 | 01E03 | 1" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6007<br>TO: PB #6A<br>3 #14 >> LSH-6007 CONTROL<br>3 #14 >> LSH-6008 CONTROL | C-01-606<br><br><br>C-01-608 |
| C-01-608 | 01E03 | 1" | 3 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6008<br>TO: PB #7A<br>3 #14 >> LSH-6008 CONTROL | C-01-607 |
| C-01-609 | 01E03 | 1" | 9 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6009<br>TO: PB #5A<br>3 #14 >> LSH-6009 CONTROL<br>3 #14 >> LSH-6010 CONTROL<br>3 #14 >> LSH-6011 CONTROL | C-01-605<br><br><br>C-01-610<br>C-01-610 |
| C-01-610 | 01E03<br>01E04 | 1" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6010<br>TO: PB #9A<br>3 #14 >> LSH-6010 CONTROL<br>3 #14 >> LSH-6011 CONTROL | C-01-609<br><br><br>C-01-611 |
| C-01-611 | 01E04 | 1" | 3 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6011<br>TO: PB #10A<br>3 #14 >> LSH-6011 CONTROL | C-01-610 |

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

| ENGINEER | SKB |
|---|---|
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-01-615 | 02E01 | 2" | 33 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PB-13 | |
| | 63E05 | | | | | | | | TO: RTU-CL | |
| | | | | | | | | | 3 #14 >> LSH-6001 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6002 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6003 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6004 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6005 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6006 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6007 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6008 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6009 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6010 CONTROL | C-01-605 |
| | | | | | | | | | 3 #14 >> LSH-6011 CONTROL | C-01-605 |
| L-01-042 | 01E02 | 2" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: POLE LIGHT | L-01-043 |
| | 02E03 | | | | | | | | TO: PB-15 | |
| | | | | | | | | | 2 #12 >> POLE LIGHT POWER | |
| L-01-043 | 02E03 | 2" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PB-15 | L-01-503 |
| | | | | | | | | | TO: PB-18 | |
| | | | | | | | | | 2 #12 >> POLE LIGHT POWER | L-01-042 |
| L-01-051 | 01E02 | 2" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: BACKWASH TANK LVL HEATER | L-01-502 |
| | | | | | | | | | TO: PB-15 | |
| | | | | | | | | | 2 #10 >> BACKWASH TANK LVL HEATER POWER | |
| L-01-061 | 01E02 | 2" | 2 | #8 | XHHW-2 | 1 | #8 | XHHW-2 | FR: ELECTRONICS ENCLOSURE | L-01-062 |
| | | | | | | | | | TO: PB-18 | |
| | | | | | | | | | 2 #8 >> ELECTRONICS ENCLOSURE POWER | |
| L-01-062 | 02E03 | 2" | 2 | #8 | XHHW-2 | 1 | #8 | XHHW-2 | FR: PB-18 | L-01-063 |
| | | | | | | | | | TO: PB-15 | |
| | | | | | | | | | 2 #8 >> ELECTRONICS ENCLOSURE POWER | L-01-061 |
| L-01-063 | 02E01 | 2" | 2 | #8 | XHHW-2 | 1 | #8 | XHHW-2 | FR: PB-15 | L-01-064 |
| | | | | | | | | | TO: PB-14 | |
| | | | | | | | | | 2 #8 >> ELECTRONICS ENCLOSURE POWER | L-01-062 |
| L-01-064 | 02E01 | 2" | 2 | #8 | XHHW-2 | 1 | #8 | XHHW-2 | FR: PB-14 | |
| | | | | | | | | | TO: RTU-CS | |
| | | | | | | | | | 2 #8 >> ELECTRONICS ENCLOSURE POWER | L-01-063 |
| L-01-185 | 02E02 | 2" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: PMP-6852 | |
| | 63E05 | | | | | | | | TO: PNL-CL | |
| | 68E03 | | | | | | | | 2 #10 >> PMP-6852 POWER | |
| L-01-501 | 01E02 | 2" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: SOUTH SECURITY GATE | L-01-502 |
| | 02E03 | | | | | | | | TO: PB-15 | |
| | | | | | | | | | 2 #10 >> SOUTH SECURITY GATE POWER | |
| L-01-502 | 02E03 | 2" | 4 | #10 | XHHW-2 | 1 | #6 | XHHW-2 | FR: PB-15 | L-01-503 |
| | | | | | | | | | TO: PB-18 | |
| | | | | | | | | | 2 #10 >> BACKWASH TANK LVL HEATER POWER | L-01-051 |
| | | | | | | | | | 2 #10 >> SOUTH SECURITY GATE POWER | L-01-501 |
| L-01-503 | 01E02 | 2" | 4 | #10 | XHHW-2 | 1 | #6 | XHHW-2 | FR: PB-18 | |
| | | | 4 | #12 | XHHW-2 | | | | TO: PNL-CELL | |
| | | | | | | | | | 2 #12 >> POLE LIGHT POWER | L-01-043 |
| | | | | | | | | | 2 #10 >> BACKWASH TANK LVL HEATER POWER | L-01-502 |
| | | | | | | | | | 2 #10 >> SOUTH SECURITY GATE POWER | L-01-502 |
| | | | | | | | | | 2 #12 >> S SECURITY GATE CAMERA POWER | L-01-542 |
| L-01-521 | 01E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: XFMR-RES | |
| | | | | | | | | | TO: PNL-CELL | |
| | | | | | | | | | 2 #12 >> XFMR-RES POWER | |
| L-01-522 | 01E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: ELECTRONICS ENCLOSURE | |
| | | | | | | | | | TO: PNL-CELL | |
| | | | | | | | | | 2 #12 >> ELECTRONICS ENCLOSURE POWER | |
| L-01-531 | 01E02 | 1.5" | 3 | #1/0 | XHHW-2 | 1 | #6 | XHHW-2 | FR: PNL-CELL | |
| | | | | | | | | | TO: XFMR-CELL | |
| | | | | | | | | | 3 #1/0 >> PNL-CELL POWER | |
| L-01-541 | 01E02 | 2" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: S SECURITY GATE CAMERA | L-01-542 |
| | 02E03 | | | | | | | | TO: PB-15 | |
| | | | | | | | | | 2 #12 >> S SECURITY GATE CAMERA POWER | |
| L-01-542 | 02E03 | 2" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PB-15 | L-01-503 |
| | | | | | | | | | TO: PB-18 | |
| | | | | | | | | | 2 #12 >> S SECURITY GATE CAMERA POWER | L-01-541 |

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

ENGINEER: SKB
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| M-01-001 | 02E03 | 4" | 1 | #2/0:15KV | 15KV-EPR | 1 | #2/0 | XHHW-2 | FR: XFMR CELL<br>TO: PB-17<br>1 #2/0:15KV >> XFMR CELL POWER | M-01-002 |
| M-01-002 | 02E03 | 4" | 1 | #2/0:15KV | 15KV-EPR | 1 | #4 | XHHW-2 | FR: PB-17<br>TO: SECTIONALIZER 2<br>1 #2/0:15KV >> XFMR CELL POWER | <br><br>M-01-001 |
| N-01-501 | 01E02 | 2" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: S SECURITY GATE CAMERA<br>TO: WEST GATE OPERATOR<br>1 CAT6 >> S SECURITY GATE CAMERA NETWORK | N-01-503 |
| N-01-502 | 01E02 | 2" | 4 | 2/C-#14 | | 1 | #14 | XHHW-2 | FR: CALLBOX<br>TO: WEST GATE OPERATOR<br>2 2/C-#14 >> CALLBOX NETWORK (TEMP)<br>2 2/C-#14 >> CALLBOX NETWORK (PERMANENT) | N-01-503 |
| N-01-503 | 02E03 | 2" | 4<br>1<br>1 | 2/C-#14 | <br>CAT6<br>12/FO | 1 | #14 | XHHW-2 | FR: WEST GATE OPERATOR<br>TO: PB-15<br>1 CAT6 >> S SECURITY GATE CAMERA NETWORK<br>2 2/C-#14 >> CALLBOX NETWORK (TEMP)<br>2 2/C-#14 >> CALLBOX NETWORK (PERMANENT)<br>1 12/FO >> S SECURITY GATE NETWORK | N-01-504<br><br>N-01-501<br>N-01-502<br>N-01-502 |
| N-01-504 | 02E03 | 2" | 2<br>1<br>1 | 2/C-#14 | <br>CAT6<br>12/FO | 1 | #14 | XHHW-2 | FR: PB-15<br>TO: PB-18<br>1 CAT6 >> S SECURITY GATE CAMERA NETWORK<br>2 2/C-#14 >> CALLBOX NETWORK (TEMP)<br>1 12/FO >> S SECURITY GATE NETWORK | N-01-521<br><br>N-01-503<br>N-01-503<br>N-01-503 |
| N-01-505 | 02E01 | 2" | 2 | 2/C-#14 | | 1 | #14 | XHHW-2 | FR: PB-15<br>TO: PB-14<br>2 2/C-#14 >> CALLBOX NETWORK (PERMANENT) | N-01-506<br><br>N-01-503 |
| N-01-506 | 02E01 | 2" | 4<br>1<br>1 | 2/C-#14 | <br>CAT6<br>12/FO | 1 | #14 | XHHW-2 | FR: PB-14<br>TO: RTU-CS<br>1 CAT6 >> S SECURITY GATE CAMERA NETWORK<br>2 2/C-#14 >> CALLBOX NETWORK (TEMP)<br>2 2/C-#14 >> CALLBOX NETWORK (PERMANENT)<br>1 12/FO >> S SECURITY GATE NETWORK | <br><br>N-01-505<br>N-01-505<br>N-01-505<br>N-01-505 |
| N-01-511 | 01E02 | 2" | 1 | 3/CS-#16 | | 1 | #14 | XHHW-2 | FR: GATE CARD READER<br>TO: PB-18<br>1 3/CS-#16 >> GATE CARD READER NETWORK | N-01-521 |
| N-01-521 | 01E02 | 2.5" | 2<br>1<br>2<br>1 | 2/C-#14<br><br><br>3/CS-#16 | <br>CAT6<br>12/FO | 1 | #14 | XHHW-2 | FR: PB-18 (INTERCEPTED FIBER OPTIC TO CULINARY RESERVOIR)<br>TO: ELECTRONICS ENCLOSURE<br>1 CAT6 >> S SECURITY GATE CAMERA NETWORK<br>2 2/C-#14 >> CALLBOX NETWORK (TEMP)<br>1 12/FO >> S SECURITY GATE NETWORK<br>1 3/CS-#16 >> GATE CARD READER NETWORK<br>1 12/FO >> CULINARY RESERVOIR NETWORK | <br><br>N-01-504<br>N-01-504<br>N-01-504<br>N-01-511 |
| N-01-525 | 01E02 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: ELECTRONICS ENCLOSURE<br>TO: PB-18<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | N-01-526 |
| N-01-526 | 02E03 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: PB-18<br>TO: PB-15<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | N-01-527<br><br>N-01-525 |
| N-01-527 | 02E01 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: PB-15<br>TO: PB-14<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | N-01-528<br><br>N-01-526 |
| N-01-528 | 02E01 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: PB-14<br>TO: RTU-CS<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | <br><br>N-01-527 |
| N-01-531 | 01E02<br>02E03 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: ELECTRONICS ENCLOSURE<br>TO: PB #2<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | N-01-922 |
| N-01-611 | 02E02<br>68E03 | 2" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CL<br>1 PULL >> SPARE | |
| N-01-901 | 68E03 | 1.5" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: VCP-6800<br>TO: J-BOX<br>1 12/FO >> VCP-6800 NETWORK | N-01-903 |

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

ENGINEER SKB
REVISION
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| N-01-902 | 68E03 | 1.5" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: VCP-6830<br>TO: J-BOX<br>1 12/FO >> VCP-6830 NETWORK | N-01-903 |
| N-01-903 | 02E02<br>63E05<br>68E03 | 2" | 2 | | 12/FO | 1 | #14 | XHHW-2 | FR: J-BOX<br>TO: RTU-CL<br>1 12/FO >> VCP-6800 NETWORK<br>1 12/FO >> VCP-6830 NETWORK | <br><br>N-01-901<br>N-01-902 |
| N-01-911 | 02E02<br>63E05 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: RTU-CL<br>TO: PB-16<br>1 12/FO >> RTU-CL NETWORK | N-01-921 |
| N-01-912 | 02E02 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: RTU-CS<br>TO: PB-16<br>1 12/FO >> RTU-CS NETWORK | N-01-921 |
| N-01-921 | 02E02<br>02E03 | 2" | 2 | | 12/FO | 1 | #14 | XHHW-2 | FR: PB-16<br>TO: PB #2<br>1 12/FO >> RTU-CL NETWORK<br>1 12/FO >> RTU-CS NETWORK | N-01-922<br><br>N-01-911<br>N-01-912 |
| N-01-922 | 01E03<br>30E10 | 3" | 3 | | 12/FO | 1 | #14 | XHHW-2 | FR: PB #2<br>TO: PB #11 (VIA SPARE 3" CONDUIT IN EXISTING DUCT BANK)<br>1 12/FO >> RTU-CL NETWORK<br>1 12/FO >> RTU-CS NETWORK<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | N-01-923<br><br>N-01-921<br>N-01-921<br>N-01-531 |
| N-01-923 | 30E10<br>71E02 | 3" | 3 | | 12/FO | 1 | #14 | XHHW-2 | FR: PB #11<br>TO: EXISTING PULLBOX (VIA EXISTING EXPOSED 3" CONDUIT)<br>1 12/FO >> RTU-CL NETWORK<br>1 12/FO >> RTU-CS NETWORK<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | N-01-924<br><br>N-01-922<br>N-01-922<br>N-01-922 |
| N-01-924 | 69E01<br>71E02 | 3" | 3 | | 12/FO | 1 | #14 | XHHW-2 | FR: EXISTING PULLBOX<br>TO: EXISTING PULLBOX<br>1 12/FO >> RTU-CL NETWORK<br>1 12/FO >> RTU-CS NETWORK<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | N-01-925<br><br>N-01-923<br>N-01-923<br>N-01-923 |
| N-01-925 | 69E01 | 2.5" | 3 | | 12/FO | 1 | #14 | XHHW-2 | FR: EXISTING PULLBOX<br>TO: LEVEL 2 NETWORK ROOM<br>1 12/FO >> RTU-CL NETWORK<br>1 12/FO >> RTU-CS NETWORK<br>1 12/FO >> ELECTRONICS ENCLOSURE NETWORK | <br><br>N-01-924<br>N-01-924<br>N-01-924 |
| N-01-931 | 30E19<br>69E01 | 1.5" | 1 | PULL | ROPE | | | | FR: EXISTING PULLBOX<br>TO: VIA CABLE TRAY<br>1 PULL >> SPARE | N-01-932 |
| N-01-932 | 69E01 | 2" | 1 | PULL | ROPE | | | | FR: CABLE TRAY<br>TO: CELL SITE EQUIP ROOM VIA EXISTING CONDUIT<br>1 PULL >> SPARE | <br><br>N-01-931 |
| P-01-031 | 02E01 | 2" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PB-15 (CONNECT EXISTING WIRES IN INTERCEPTED DUCTBANK<br>TO: PB-14<br>3 #12 >> RESERVOIR TANK LIGHT & HEATING | P-01-032 |
| P-01-032 | 02E01 | 2" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PB-14<br>TO: PP-CS<br>3 #12 >> RESERVOIR TANK LIGHT & HEATING | <br><br>P-01-031 |
| P-01-071 | 01E05<br>30E03 | 3" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: MCC-BL<br>TO: PB #7 (VIA EXISTING DUCT BANK)<br>3 350 >> MCC-BL POWER | P-01-072 |
| P-01-072 | 02E03 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB #7<br>TO: SWBD-APF<br>3 350 >> MCC-BL POWER | <br><br>P-01-071 |
| P-01-081 | 01E05<br>30E03 | 3" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: MCC-BL<br>TO: PB #7 (VIA EXISTING DUCT BANK)<br>3 350 >> MCC-BL POWER | P-01-082 |
| P-01-082 | 02E03 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB #7<br>TO: SWBD-APF<br>3 350 >> MCC-BL POWER | <br><br>P-01-081 |
| P-01-091 | 02E03 | 4" | 4 | 500 | XHHW-2 | 1 | #1/0 | XHHW-2 | FR: SWBD-APF<br>TO: XFMR-APF<br>4 500 >> SWBD-APF POWER | |

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

ENGINEER SKB
REVISION
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-01-092 | 02E03 | 4" | 4 | 500 | XHHW-2 | 1 | #1/0 | XHHW-2 | FR: SWBD-APF<br>TO: XFMR-APF<br>4 500 >> SWBD-APF POWER | |
| P-01-093 | 02E03 | 4" | 4 | 500 | XHHW-2 | 1 | #1/0 | XHHW-2 | FR: SWBD-APF<br>TO: XFMR-APF<br>4 500 >> SWBD-APF POWER | |
| P-01-101 | 02E01<br>65E02 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: MCC-CS<br>TO: PB-14<br>3 #4/0 >> MCC-CS POWER | P-01-102 |
| P-01-102 | 02E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: PB-14<br>TO: PB-13<br>3 #4/0 >> MCC-CS POWER | P-01-103<br>P-01-101 |
| P-01-103 | 02E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: PB-13<br>TO: SWBD-CS<br>3 #4/0 >> MCC-CS POWER | P-01-102 |
| P-01-105 | 02E01<br>65E02 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: MCC-CS<br>TO: PB-14<br>3 #4/0 >> MCC-CS POWER | P-01-106 |
| P-01-106 | 02E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB-14<br>TO: PB-13<br>3 #4/0 >> MCC-CS POWER | P-01-107<br>P-01-105 |
| P-01-107 | 02E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB-13<br>TO: SWBD-CS<br>3 #4/0 >> MCC-CS POWER | P-01-106 |
| P-01-121 | 02E01<br>63E05 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: MCC-CL<br>TO: PB-13<br>3 #4/0 >> MCC-CL POWER | P-01-122 |
| P-01-122 | 02E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: PB-13<br>TO: SWBD-CS<br>3 #4/0 >> MCC-CL POWER | P-01-121 |
| P-01-125 | 02E01<br>63E05 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: MCC-CL<br>TO: PB-13<br>3 #4/0 >> MCC-CL POWER | P-01-126 |
| P-01-126 | 02E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #2 | XHHW-2 | FR: PB-13<br>TO: SWBD-CS<br>3 #4/0 >> MCC-CL POWER | P-01-125 |
| P-01-141 | 02E01 | 4" | 3 | 500 | XHHW-2 | 1 | #1 | XHHW-2 | FR: SWBD-CS<br>TO: PB-12<br>3 500 >> SWBD-CS POWER | P-01-151 |
| P-01-142 | 02E01 | 4" | 3 | 500 | XHHW-2 | 1 | #1 | XHHW-2 | FR: SWBD-CS<br>TO: PB-12<br>3 500 >> SWBD-CS POWER | P-01-152 |
| P-01-151 | 02E01 | 4" | 3 | 500 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB-12<br>TO: UNIT SUBSTATION<br>3 500 >> SWBD-CS POWER | P-01-141 |
| P-01-152 | 02E01 | 4" | 3 | 500 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB-12<br>TO: UNIT SUBSTATION<br>3 500 >> SWBD-CS POWER | P-01-142 |
| P-01-161 | 02E02<br>63E05<br>68E03 | 4" | 3 | #3/0 | XHHW-2 | 1 | #6 | XHHW-2 | FR: PP-PAC<br>TO: MCC-CL<br>3 #3/0 >> PP-PAC POWER | |
| P-01-201 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-15<br>TO: PB-14<br>1 PULL >> SPARE POWER | P-01-202 |
| P-01-202 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: MCC-CS<br>1 PULL >> SPARE POWER | P-01-201 |
| P-01-311 | 02E03 | 4" | 3 | 500 | XHHW-2 | 1 | #2/0 | XHHW-2 | FR: PB #7<br>TO: SWBD-APF<br>3 500 >> ATS MCC-A1 POWER (EXISTING CABLE | |
| P-01-321 | 02E03 | 4" | 3 | 500 | XHHW-2 | 1 | #2/0 | XHHW-2 | FR: PB #7<br>TO: SWBD-APF<br>3 500 >> ATS MCC-A1 POWER (EXISTING CABLE | |

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

| | |
|---|---|
| ENGINEER | SKB |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-01-331 | 02E03 | 4" | 3 | 500 | XHHW-2 | 1 | #2/0 | XHHW-2 | FR: PB #7<br>TO: SWBD-APF<br>3 500 >> ATS MCC-A1 POWER (NEW SPLICED CE | |
| P-01-411 | 01E05 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: MCC-WW<br>TO: PB #7 (VIA EXISTING DUCT BANK)<br>3 350 >> MCC-WW POWER | P-01-412 |
| P-01-412 | 02E03 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB #7<br>TO: SWBD-APF<br>3 350 >> MCC-WW POWER | P-01-411 |
| P-01-421 | 01E05 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: MCC-WW<br>TO: PB #7 (VIA EXISTING DUCT BANK)<br>3 350 >> MCC-WW POWER | P-01-422 |
| P-01-422 | 02E03 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: PB #7<br>TO: SWBD-APF<br>3 350 >> MCC-WW POWER | P-01-421 |
| P-01-431 | 02E03 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: SWBD-APF<br>TO: UNIT SUBSTATION<br>3 350 >> MCC-WW POWER (EXISTING CABLE) | |
| P-01-441 | 02E03 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: SWBD-APF<br>TO: UNIT SUBSTATION<br>3 350 >> MCC-WW POWER (EXISTING CABLE) | |
| P-01-521 | 01E02 | 2" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PB-18 (INTERCEPTED 480V WIRES TO CULINARY RESERVOIR)<br>TO: XFMR-RES<br>3 #12 >> CULINARY RESERVOIR POWER (TEMP) | |
| X-01-011 | 02E03 | 4" | 1 | PULL | ROPE | | | | FR: XFMR CELL<br>TO: PB-17<br>1 PULL >> SPARE | X-01-012 |
| X-01-012 | 02E03 | 4" | 1 | PULL | ROPE | | | | FR: PB-17<br>TO: SECTIONALIZER 2<br>1 PULL >> SPARE | X-01-011 |
| X-01-051 | 01E02<br>02E03 | 2" | 1 | PULL | ROPE | | | | FR: SOUTH SECURITY GATE<br>TO: PB-15<br>1 PULL >> SPARE | X-01-052 |
| X-01-052 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-15<br>TO: PB-14<br>1 PULL >> SPARE | X-01-053<br>X-01-051 |
| X-01-053 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: STUB UP IN CS BLDG ELEC ROOM<br>1 PULL >> SPARE | X-01-052 |
| X-01-061 | 02E03 | 2" | 1 | PULL | ROPE | | | | FR: SOUTH SECURITY GATE<br>TO: PB-15<br>1 PULL >> SPARE | X-01-062 |
| X-01-062 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-15<br>TO: PB-14<br>1 PULL >> SPARE | X-01-063<br>X-01-061 |
| X-01-063 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: STUB-UP IN CS BLDG ELEC ROOM<br>1 PULL >> SPARE | X-01-062 |
| X-01-071 | 01E02<br>02E03 | 5" | 1 | PULL | ROPE | | | | FR: RELOCATED PULLBOX<br>TO: PB-17<br>1 PULL >> SPARE | |
| X-01-072 | 02E03 | 5" | 1 | PULL | ROPE | | | | FR: PB-17<br>TO: SECTIONALIZER 2<br>1 PULL >> SPARE | |
| X-01-094 | 02E03 | 4" | 1 | PULL | ROPE | | | | FR: SWBD-APF<br>TO: XFMR-APF<br>1 PULL >> SPARE | |
| X-01-111 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: MCC-CS<br>TO: PB-14<br>1 PULL >> SPARE | X-01-112 |
| X-01-112 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: PB-13<br>1 PULL >> SPARE | X-01-113<br>X-01-111 |

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

| | |
|---|---|
| ENGINEER | SKB |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| X-01-113 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-13<br>TO: SWBD-CS<br>1 PULL >> SPARE | X-01-112 |
| X-01-115 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: MCC-CS<br>TO: PB-14<br>1 PULL >> SPARE | X-01-116 |
| X-01-116 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: PB-13<br>1 PULL >> SPARE | X-01-117<br>X-01-115 |
| X-01-117 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-13<br>TO: SWBD-CS<br>1 PULL >> SPARE | X-01-116 |
| X-01-131 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: MCC-CL<br>TO: PB-13<br>1 PULL >> SPARE | X-01-132 |
| X-01-132 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-13<br>TO: SWBD-CS<br>1 PULL >> SPARE | X-01-131 |
| X-01-135 | 02E01<br>63E05 | 4" | 1 | PULL | ROPE | | | | FR: MCC-CL<br>TO: PB-13<br>1 PULL >> SPARE | X-01-136 |
| X-01-136 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-13<br>TO: SWBD-CS<br>1 PULL >> SPARE | X-01-135 |
| X-01-143 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: SWBD-CS<br>TO: PB-12<br>1 PULL >> SPARE | |
| X-01-144 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: SWBD-CS<br>TO: PB-12<br>1 PULL >> SPARE | |
| X-01-153 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-12<br>TO: UNIT SUBSTATION<br>1 PULL >> SPARE | |
| X-01-154 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-12<br>TO: UNIT SUBSTATION<br>1 PULL >> SPARE | |
| X-01-171 | 02E02<br>63E05<br>68E03 | 4" | 1 | PULL | ROPE | | | | FR: PAC ROOM<br>TO: CHLORINE ELECTRICAL ROOM<br>1 PULL >> SPARE | |
| X-01-175 | 02E02<br>63E05<br>68E03 | 2" | 1 | PULL | ROPE | | | | FR: PAC ROOM<br>TO: CHLORINE ELECTRICAL ROOM<br>1 PULL >> SPARE | |
| X-01-213 | 01E02<br>02E01 | 4" | 1 | PULL | ROPE | | | | FR: HH-101<br>TO: PB-14<br>1 PULL >> SPARE | X-01-214 |
| X-01-214 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: STUB-UP IN CS BLDG ELEC ROOM<br>1 PULL >> SPARE | X-01-213 |
| X-01-223 | 01E02<br>02E01 | 4" | 1 | PULL | ROPE | | | | FR: HH-101<br>TO: PB-14<br>1 PULL >> SPARE | X-01-224 |
| X-01-224 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: STUB-UP IN CS BLDG ELEC ROOM<br>1 PULL >> SPARE | X-01-223 |
| X-01-301 | 02E02 | 2" | 1 | PULL | ROPE | | | | FR: STUB UP IN CS BLDG ELEC ROOM<br>TO: PB-16<br>1 PULL >> SPARE | |
| X-01-311 | 02E02<br>63E05 | 2" | 1 | PULL | ROPE | | | | FR: STUB UP IN CHLORINE BLDG ELEC ROOM<br>TO: PB-16<br>1 PULL >> SPARE | |
| X-01-321 | 02E02<br>63E05<br>68E03 | 2" | 1 | PULL | ROPE | | | | FR: PAC ROOM<br>TO: STUB UP IN CHLORINE BLDG ELEC ROOM<br>1 PULL >> SPARE | |

# CONDUIT SCHEDULE AREA 01

## JORDAN VALLEY WATER TREATMENT PLANT

## SITE

ENGINEER SKB
REVISION
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| X-01-331 | 02E02<br>02E03 | 2" | 1 | PULL | ROPE | | | | FR: PB-16<br>TO: PB #2<br>1 PULL >> SPARE | |
| X-01-351 | 02E01 | 4" | 1 | PULL | ROPE | | | | FR: RTU-CS<br>TO: PB-14<br>1 PULL >> SPARE | |
| X-01-355 | 02E01<br>63E05 | 4" | 1 | PULL | ROPE | | | | FR: RTU-CL<br>TO: PB-13<br>1 PULL >> SPARE | |
| X-01-461 | 02E03 | 4" | 1 | PULL | ROPE | | | | FR: SWBD-APF<br>TO: PB #7<br>1 PULL >> SPARE | |
| X-01-471 | 02E03 | 4" | 1 | PULL | ROPE | | | | FR: SWBD-APF<br>TO: PB #7<br>1 PULL >> SPARE | |
| X-01-481 | 02E03 | 4" | 1 | PULL | ROPE | | | | FR: SWBD-APF<br>TO: PB #7<br>1 PULL >> SPARE | |
| X-01-551 | 02E03 | 2" | 1 | PULL | ROPE | | | | FR: PB-18<br>TO: PB-15<br>1 PULL >> SPARE | |
| X-01-561 | 02E03 | 2" | 1 | PULL | ROPE | | | | FR: PB-18<br>TO: PB-15<br>1 PULL >> SPARE | |
| X-01-571 | 02E03 | 2" | 1 | PULL | ROPE | | | | FR: PB-18<br>TO: PB-15<br>1 PULL >> SPARE | |

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990B

CONDUIT SCHEDULE
AREA 30

# PART 1 GENERAL

## 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */FO: Fiber optic (* indicates strand count).
   4. CAT5e: Category 5 enhanced Ethernet cable.
   5. CAT6: Category 6 Ethernet cable.
   6. MFR: Manufacturer or vendor furnished cable.
   7. PULL: Pull Rope.
   8. RS-485 RS-485 cable.

# PART 2 PRODUCTS

Not Used.

# PART 3 EXECUTION

## 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-010 | 30E03 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MCC-BL<br>TO: RTU-BL<br>7 #14 >> MCC-BL CONTROL<br>3 #14 >> SPARE<br>2 #14 >> SPD-3001 CONTROL | |
| C-30-101 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3010<br>TO: RTU-NFL1<br>2 #14 >> AIT-3010 CONTROL | |
| C-30-102 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3010<br>TO: RTU-NFL1<br>2 #14 >> FSL-3010 CONTROL | |
| C-30-103 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3011<br>TO: RTU-NFL1<br>2 #14 >> FIT-3011 CONTROL | |
| C-30-104 | 30E14 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3011<br>TO: RTU-NFL1<br>6 #14 >> FV-3011 CONTROL | |
| C-30-105 | 30E14 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3011<br>TO: RTU-NFL1<br>2 #14 >> LIT-3011 CONTROL | |
| C-30-106 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3012<br>TO: RTU-NFL1<br>6 #14 >> FV-3012 CONTROL | |
| C-30-107 | 30E06 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3013<br>TO: RTU-NFL1<br>6 #14 >> FV-3013 CONTROL | |
| C-30-108 | 30E06 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3014<br>TO: FV-3014<br>7 #14 >> LCP-3014 CONTROL | |
| C-30-109 | 30E06 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3014<br>TO: RTU-NFL1<br>8 #14 >> FV-3014 CONTROL | |
| C-30-111 | 30E14 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3016<br>TO: RTU-NFL1<br>8 #14 >> FV-3016 CONTROL | |
| C-30-112 | 30E14 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3017<br>TO: RTU-NFL1<br>8 #14 >> FV-3017 CONTROL | |
| C-30-120 | 30E14 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3011<br>TO: RTU-NFL1<br>2 #14 >> AIT-3011 CONTROL POWER | |
| C-30-151 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3020<br>TO: RTU-SFL2<br>2 #14 >> AIT-3020 CONTROL | |
| C-30-152 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3020<br>TO: RTU-SFL2<br>2 #14 >> FSL-3020 CONTROL | |
| C-30-153 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3021<br>TO: RTU-SFL2<br>2 #14 >> FIT-3021 CONTROL | |
| C-30-154 | 30E18 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3021<br>TO: RTU-SFL2<br>6 #14 >> FV-3021 CONTROL | |
| C-30-155 | 30E18 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3021<br>TO: RTU-SFL2<br>2 #14 >> LIT-3021 CONTROL | |
| C-30-156 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3022<br>TO: RTU-SFL2<br>6 #14 >> FV-3022 CONTROL | |
| C-30-157 | 30E06 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3023<br>TO: RTU-SFL2<br>6 #14 >> FV-3023 CONTROL | |
| C-30-158 | 30E06 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3024<br>TO: FV-3024<br>7 #14 >> LCP-3024 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-159 | 30E06 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3024<br>TO: RTU-SFL2<br>8 #14 >> FV-3024 CONTROL/STATUS | |
| C-30-161 | 30E18 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3026<br>TO: RTU-SFL2<br>8 #14 >> FV-3026 CONTROL | |
| C-30-162 | 30E18 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3027<br>TO: RTU-SFL2<br>8 #14 >> FV-3027 CONTROL | |
| C-30-170 | 30E18 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3021<br>TO: RTU-SFL2<br>2 #14 >> AIT-3021 CONTROL | |
| C-30-201 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3030<br>TO: RTU-NFL3<br>2 #14 >> AIT-3030 CONTROL | |
| C-30-202 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3030<br>TO: RTU-NFL3<br>2 #14 >> FSL-3030 CONTROL | |
| C-30-203 | 30E07 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3031<br>TO: RTU-NFL3<br>2 #14 >> FIT-3031 CONTROL | |
| C-30-204 | 30E14 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3031<br>TO: RTU-NFL3<br>6 #14 >> FV-3031 CONTROL | |
| C-30-205 | 30E14 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3031<br>TO: RTU-NFL3<br>2 #14 >> LIT-3031 CONTROL | |
| C-30-206 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3032<br>TO: RTU-NFL3<br>6 #14 >> FV-3032 CONTROL | |
| C-30-207 | 30E06 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3033<br>TO: RTU-NFL3<br>6 #14 >> FV-3033 CONTROL | |
| C-30-208 | 30E07 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3034<br>TO: FV-3034<br>7 #14 >> LCP-3034 CONTROL | |
| C-30-209 | 30E06 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3034<br>TO: RTU-NFL3<br>8 #14 >> FV-3034 CONTROL | |
| C-30-211 | 30E14 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3036<br>TO: RTU-NFL3<br>8 #14 >> FV-3036 CONTROL | |
| C-30-212 | 30E14 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3037<br>TO: RTU-NFL3<br>8 #14 >> FV-3037 CONTROL | |
| C-30-220 | 30E14 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3031<br>TO: RTU-NFL3<br>2 #14 >> AIT-3031 CONTROL | |
| C-30-251 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3040<br>TO: RTU-SFL4<br>2 #14 >> AIT-3040 CONTROL | |
| C-30-252 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3040<br>TO: RTU-SFL4<br>2 #14 >> FSL-3040 CONTROL | |
| C-30-253 | 30E07 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3041<br>TO: RTU-SFL4<br>2 #14 >> FIT-3041 CONTROL | |
| C-30-254 | 30E18 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3041<br>TO: RTU-SFL4<br>6 #14 >> FV-3041 CONTROL | |
| C-30-255 | 30E18 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3041<br>TO: RTU-SFL4<br>2 #14 >> LIT-3041 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-256 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3042<br>TO: RTU-SFL4<br>6 #14 >> FV-3042 CONTROL | |
| C-30-257 | 30E06 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3043<br>TO: RTU-SFL4<br>6 #14 >> FV-3043 CONTROL | |
| C-30-258 | 30E07 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3044<br>TO: FV-3044<br>7 #14 >> LCP-3044 CONTROL | |
| C-30-259 | 30E06 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3044<br>TO: RTU-SFL4<br>8 #14 >> FV-3044 CONTROL | |
| C-30-261 | 30E18 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3046<br>TO: RTU-SFL4<br>8 #14 >> FV-3046 CONTROL | |
| C-30-262 | 30E18 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3047<br>TO: RTU-SFL4<br>8 #14 >> FV-3047 CONTROL | |
| C-30-270 | 30E18 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3041<br>TO: RTU-SFL4<br>2 #14 >> AIT-3041 CONTROL | |
| C-30-301 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3050<br>TO: RTU-NFL5<br>2 #14 >> AIT-3050 CONTROL | |
| C-30-302 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3050<br>TO: RTU-NFL5<br>2 #14 >> FSL-3050 CONTROL | |
| C-30-303 | 30E07 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3051<br>TO: RTU-NFL5<br>2 #14 >> FIT-3051 CONTROL | |
| C-30-304 | 30E14 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3051<br>TO: RTU-NFL5<br>6 #14 >> FV-3051 CONTROL | |
| C-30-305 | 30E14 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3051<br>TO: RTU-NFL5<br>2 #14 >> LIT-3051 CONTROL | |
| C-30-306 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3052<br>TO: RTU-NFL5<br>6 #14 >> FV-3052 CONTROL | |
| C-30-307 | 30E06 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3053<br>TO: RTU-NFL5<br>6 #14 >> FV-3053 CONTROL | |
| C-30-308 | 30E07 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3054<br>TO: FV-3054<br>7 #14 >> LCP-3054 CONTROL | |
| C-30-309 | 30E06 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3054<br>TO: RTU-NFL5<br>8 #14 >> FV-3054 CONTROL | |
| C-30-311 | 30E14 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3056<br>TO: RTU-NFL5<br>8 #14 >> FV-3056 CONTROL | |
| C-30-312 | 30E14 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3057<br>TO: RTU-NFL5<br>8 #14 >> FV-3057 CONTROL | |
| C-30-320 | 30E14 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3051<br>TO: RTU-NFL5<br>2 #14 >> AIT-3051 CONTROL | |
| C-30-351 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3060<br>TO: RTU-SFL6<br>2 #14 >> AIT-3060 CONTROL | |
| C-30-352 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3060<br>TO: RTU-SFL6<br>2 #14 >> FSL-3060 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER AJB
REVISION 0
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-353 | 30E07 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3061<br>TO: RTU-SFL6<br>2 #14 >> FIT-3061 CONTROL | |
| C-30-354 | 30E18 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3061<br>TO: RTU-SFL6<br>6 #14 >> FV-3061 CONTROL | |
| C-30-355 | 30E18 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3061<br>TO: RTU-SFL6<br>2 #14 >> LIT-3061 CONTROL | |
| C-30-356 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3062<br>TO: RTU-SFL6<br>6 #14 >> FV-3062 CONTROL | |
| C-30-357 | 30E06 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3063<br>TO: RTU-SFL6<br>6 #14 >> FV-3063 CONTROL | |
| C-30-358 | 30E07 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3064<br>TO: FV-3064<br>7 #14 >> LCP-3064 CONTROL | |
| C-30-359 | 30E06 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3064<br>TO: RTU-SFL6<br>8 #14 >> FV-3064 CONTROL | |
| C-30-361 | 30E18 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3066<br>TO: RTU-SFL6<br>8 #14 >> FV-3066 CONTROL | |
| C-30-362 | 30E18 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3067<br>TO: RTU-SFL6<br>8 #14 >> FV-3067 CONTROL | |
| C-30-370 | 30E18 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3061<br>TO: RTU-SFL6<br>2 #14 >> AIT-3061 CONTROL | |
| C-30-401 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3070<br>TO: RTU-NFL7<br>2 #14 >> AIT-3070 CONTROL | |
| C-30-402 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3070<br>TO: RTU-NFL7<br>2 #14 >> FSL-3070 CONTROL | |
| C-30-403 | 30E05<br>30E13 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3071<br>TO: RTU-NFL7<br>2 #14 >> AIT-3071 CONTROL | |
| C-30-404 | 30E13 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3071<br>TO: RTU-NFL7<br>8 #14 >> FV-3071 CONTROL | |
| C-30-405 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3071<br>TO: RTU-NFL7<br>2 #14 >> FIT-3071 CONTROL | |
| C-30-406 | 30E13 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3071<br>TO: RTU-NFL7<br>2 #14 >> LIT-3071 24VDC POWER | |
| C-30-407 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3072<br>TO: FV-3072<br>7 #14 >> LCP-3072 CONTROL | |
| C-30-408 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3072<br>TO: RTU-NFL7<br>6 #14 >> FV-3072 CONTROL | |
| C-30-410 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3073<br>TO: FV-3073<br>7 #14 >> LCP-3073 CONTROL | |
| C-30-411 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3073<br>TO: RTU-NFL7<br>6 #14 >> FV-3073 CONTROL | |
| C-30-413 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3074<br>TO: FV-3074<br>7 #14 >> LCP-3074 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-414 | 30E05 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3074<br>TO: RTU-NFL7<br>8 #14 >> FV-3074 CONTROL | |
| C-30-417 | 30E13 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3076<br>TO: FV-3076<br>7 #14 >> LCP-3076 CONTROL | |
| C-30-418 | 30E13 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3076<br>TO: RTU-NFL7<br>8 #14 >> FV-3076 CONTROL | |
| C-30-420 | 30E13 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3077<br>TO: RTU-NFL7<br>6 #14 >> FV-3077 CONTROL | |
| C-30-451 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3080<br>TO: RTU-SFL8<br>2 #14 >> AIT-3080 CONTROL | |
| C-30-452 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3080<br>TO: RTU-SFL8<br>2 #14 >> RTU-SFL8 | |
| C-30-453 | 30E05<br>30E17 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3081<br>TO: RTU-SFL8<br>2 #14 >> AIT-3081 CONTROL | |
| C-30-454 | 30E17 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3081<br>TO: RTU-SFL8<br>8 #14 >> FV-3081 CONTROL | |
| C-30-455 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3081<br>TO: RTU-SFL8<br>2 #14 >> FIT-3081 CONTROL | |
| C-30-456 | 30E17 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3081<br>TO: RTU-SFL8<br>2 #14 >> LIT-3081 24VDC POWER | |
| C-30-457 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3082<br>TO: FV-3082<br>7 #14 >> LCP-3082 CONTROL | |
| C-30-458 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3082<br>TO: RTU-SFL8<br>6 #14 >> FV-3082 CONTROL | |
| C-30-460 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3083<br>TO: FV-3083<br>7 #14 >> LCP-3083 CONTROL | |
| C-30-461 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3083<br>TO: RTU-SFL8<br>6 #14 >> FV-3083 CONTROL | |
| C-30-463 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3084<br>TO: FV-3084<br>7 #14 >> LCP-3084 CONTROL | |
| C-30-464 | 30E05 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3084<br>TO: RTU-SFL8<br>8 #14 >> FV-3084 CONTROL | |
| C-30-467 | 30E17 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3086<br>TO: FV-3086<br>7 #14 >> LCP-3086 CONTROL | |
| C-30-468 | 30E17 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3086<br>TO: RTU-SFL8<br>8 #14 >> FV-3086 CONTROL | |
| C-30-470 | 30E17 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3087<br>TO: RTU-SFL8<br>6 #14 >> FV-3087 CONTROL | |
| C-30-501 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3090<br>TO: RTU-NFL9<br>2 #14 >> AIT-3090 CONTROL | |
| C-30-502 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3090<br>TO: RTU-NFL9<br>2 #14 >> FSL-3090 STATUS | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-503 | 30E05<br>30E13 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3091<br>TO: RTU-NFL9<br>2 #14 >> AIT-3091 CONTROL | |
| C-30-504 | 30E13 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3091<br>TO: RTU-NFL9<br>8 #14 >> FV-3091 CONTROL | |
| C-30-505 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3091<br>TO: RTU-NFL9<br>2 #14 >> FIT-3091 CONTROL | |
| C-30-506 | 30E13 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3091<br>TO: RTU-NFL9<br>2 #14 >> LIT-3091 24VDC POWER | |
| C-30-507 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3092<br>TO: FV-3092<br>7 #14 >> LCP-3092 CONTROL | |
| C-30-508 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3092<br>TO: RTU-NFL9<br>6 #14 >> FV-3092 CONTROL | |
| C-30-510 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3093<br>TO: FV-3093<br>7 #14 >> LCP-3093 CONTROL | |
| C-30-511 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3093<br>TO: RTU-NFL9<br>6 #14 >> FV-3093 CONTROL | |
| C-30-513 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3094<br>TO: FV-3094<br>7 #14 >> LCP-3094 CONTROL | |
| C-30-514 | 30E05 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3094<br>TO: RTU-NFL9<br>8 #14 >> FV-3094 CONTROL | |
| C-30-517 | 30E13 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3096<br>TO: FV-3096<br>7 #14 >> LCP-3096 CONTROL | |
| C-30-518 | 30E13 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3096<br>TO: RTU-NFL9<br>8 #14 >> FV-3096 CONTROL | |
| C-30-520 | 30E13 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3097<br>TO: RTU-NFL9<br>6 #14 >> FV-3097 CONTROL | |
| C-30-551 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3100<br>TO: RTU-SFL10<br>2 #14 >> AIT-3100 CONTROL | |
| C-30-552 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3100<br>TO: RTU-SFL10<br>2 #14 >> FSL-3100 STATUS | |
| C-30-553 | 30E05<br>30E17 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3101<br>TO: RTU-SFL10<br>2 #14 >> AIT-3101 CONTROL | |
| C-30-554 | 30E17 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3101<br>TO: RTU-SFL10<br>8 #14 >> FV-3101 CONTROL | |
| C-30-555 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3101<br>TO: RTU-SFL10<br>2 #14 >> FIT-3101 CONTROL | |
| C-30-556 | 30E17 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3101<br>TO: RTU-SFL10<br>6 #14 >> LIT-3101 CONTROL | |
| C-30-557 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3102<br>TO: FV-3102<br>7 #14 >> LCP-3102 CONTROL | |
| C-30-558 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3102<br>TO: RTU-SFL10<br>6 #14 >> FV-3102 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| ENGINEER | AJB |
|---|---|
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-560 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3103<br>TO: FV-3103<br>7 #14 >> LCP-3103 CONTROL | |
| C-30-561 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3103<br>TO: RTU-SFL10<br>6 #14 >> FV-3103 CONTROL | |
| C-30-563 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3104<br>TO: FV-3104<br>7 #14 >> LCP-3104 CONTROL | |
| C-30-564 | 30E05 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3104<br>TO: RTU-SFL10<br>8 #14 >> FV-3104 CONTROL | |
| C-30-567 | 30E17 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3106<br>TO: FV-3106<br>7 #14 >> LCP-3106 CONTROL | |
| C-30-568 | 30E17 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3106<br>TO: RTU-SFL10<br>8 #14 >> FV-3106 CONTROL | |
| C-30-570 | 30E17 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3107<br>TO: RTU-SFL10<br>6 #14 >> FV-3107 CONTROL | |
| C-30-601 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3110<br>TO: RTU-NFL11<br>2 #14 >> AIT-3110 CONTROL | |
| C-30-602 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3110<br>TO: RTU-NFL11<br>2 #14 >> FSL-3110 STATUS | |
| C-30-603 | 30E05<br>30E13 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3111<br>TO: RTU-NFL11<br>2 #14 >> AIT-3111 CONTROL | |
| C-30-604 | 30E13 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3111<br>TO: RTU-NFL11<br>8 #14 >> FV-3111 CONTROL | |
| C-30-605 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3111<br>TO: RTU-NFL11<br>2 #14 >> FIT-3111 CONTROL | |
| C-30-606 | 30E13 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3111<br>TO: RTU-NFL11<br>2 #14 >> LIT-3111 24VDC POWER | |
| C-30-607 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3112<br>TO: FV-3112<br>7 #14 >> LCP-3112 CONTROL | |
| C-30-608 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3112<br>TO: RTU-NFL11<br>6 #14 >> FV-3112 CONTROL | |
| C-30-610 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3113<br>TO: FV-3113<br>7 #14 >> LCP-3113 CONTROL | |
| C-30-611 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3113<br>TO: RTU-NFL11<br>6 #14 >> FV-3113 CONTROL | |
| C-30-613 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3114<br>TO: FV-3114<br>7 #14 >> LCP-3114 CONTROL | |
| C-30-614 | 30E05 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3114<br>TO: RTU-NFL11<br>8 #14 >> FV-3114 CONTROL | |
| C-30-617 | 30E13 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3116<br>TO: FV-3116<br>7 #14 >> LCP-3116 CONTROL | |
| C-30-618 | 30E13 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3116<br>TO: RTU-NFL11<br>8 #14 >> FV-3116 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-620 | 30E13 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3117<br>TO: RTU-NFL11<br>6 #14 >> FV-3117 CONTROL | |
| C-30-651 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3120<br>TO: RTU-SFL12<br>2 #14 >> AIT-3120 CONTROL | |
| C-30-652 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3120<br>TO: RTU-SFL12<br>2 #14 >> FSL-3120 STATUS | |
| C-30-653 | 30E05<br>30E17 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3121<br>TO: RTU-SFL12<br>2 #14 >> AIT-3121 CONTROL | |
| C-30-654 | 30E17 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3121<br>TO: RTU-SFL12<br>8 #14 >> FV-3121 CONTROL | |
| C-30-655 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3121<br>TO: RTU-SFL12<br>2 #14 >> FIT-3121 CONTROL | |
| C-30-656 | 30E17 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3121<br>TO: RTU-SFL12<br>2 #14 >> LIT-3121 24VDC POWER | |
| C-30-657 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3122<br>TO: FV-3122<br>7 #14 >> LCP-3122 CONTROL | |
| C-30-658 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3122<br>TO: RTU-SFL12<br>6 #14 >> FV-3122 CONTROL | |
| C-30-660 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3123<br>TO: FV-3123<br>7 #14 >> LCP-3123 CONTROL | |
| C-30-661 | 30E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3123<br>TO: RTU-SFL12<br>6 #14 >> FV-3123 CONTROL | |
| C-30-663 | 30E05 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3124<br>TO: FV-3124<br>7 #14 >> LCP-3124 CONTROL | |
| C-30-664 | 30E05 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3124<br>TO: RTU-SFL12<br>8 #14 >> FV-3124 CONTROL | |
| C-30-667 | 30E17 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3126<br>TO: FV-3126<br>7 #14 >> LCP-3126 CONTROL | |
| C-30-668 | 30E17 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3126<br>TO: RTU-SFL12<br>8 #14 >> FV-3126 CONTROL | |
| C-30-670 | 30E17 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3127<br>TO: RTU-SFL12<br>6 #14 >> FV-3127 CONTROL | |
| C-30-691 | 30E19 | 1" | 1 | PULL | ROPE | | | | FR: FILTER 8 EXIT DOOR SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-30-695 | 30E19 | 1" | 1 | PULL | ROPE | | | | FR: FILTER 7 EXIT DOOR SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-30-698 | 30E19 | 1" | 1 | PULL | ROPE | | | | FR: LEVEL 1 TUNNEL DOOR SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-30-701 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3130<br>TO: RTU-NFL13<br>2 #14 >> AIT-3130 CONTROL | |
| C-30-702 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3130<br>TO: RTU-NFL13<br>2 #14 >> FSL-3130 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-703 | 30E04<br>30E12 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3131<br>TO: RTU-NFL13<br>2 #14 >> AIT-3131 CONTROL | |
| C-30-704 | 30E12 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3131<br>TO: RTU-NFL13<br>8 #14 >> FV-3131 CONTROL | |
| C-30-705 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3131<br>TO: RTU-NFL13<br>2 #14 >> FIT-3131 CONTROL | |
| C-30-706 | 30E12 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3131<br>TO: RTU-NFL13<br>2 #14 >> LIT-3131 24VDC POWER | |
| C-30-707 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3132<br>TO: FV-3132<br>7 #14 >> LCP-3132 CONTROL | |
| C-30-708 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3132<br>TO: RTU-NFL13<br>6 #14 >> FV-3132 CONTROL | |
| C-30-710 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3133<br>TO: FV-3133<br>7 #14 >> LCP-3133 CONTROL | |
| C-30-711 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3133<br>TO: RTU-NFL13<br>6 #14 >> FV-3133 CONTROL | |
| C-30-713 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3134<br>TO: FV-3134<br>7 #14 >> LCP-3134 CONTROL | |
| C-30-714 | 30E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3134<br>TO: RTU-NFL13<br>8 #14 >> FV-3134 CONTROL | |
| C-30-717 | 30E12 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3136<br>TO: FV-3136<br>7 #14 >> LCP-3136 CONTROL | |
| C-30-718 | 30E12 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3136<br>TO: RTU-NFL13<br>8 #14 >> FV-3136 CONTROL | |
| C-30-720 | 30E12 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3137<br>TO: RTU-NFL13<br>6 #14 >> FV-3137 CONTROL | |
| C-30-751 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3140<br>TO: RTU-SFL14<br>2 #14 >> AIT-3140 CONTROL | |
| C-30-752 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3140<br>TO: RTU-SFL14<br>2 #14 >> FSL-3140 CONTROL | |
| C-30-753 | 30E04<br>30E16 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3141<br>TO: RTU-SFL14<br>2 #14 >> AIT-3141 CONTROL | |
| C-30-754 | 30E16 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3141<br>TO: RTU-SFL14<br>8 #14 >> FV-3141 CONTROL | |
| C-30-755 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3141<br>TO: RTU-SFL14<br>2 #14 >> FIT-3141 CONTROL | |
| C-30-756 | 30E16 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3141<br>TO: RTU-SFL14<br>2 #14 >> LIT-3141 CONTROL POWER | |
| C-30-757 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3142<br>TO: FV-3142<br>7 #14 >> LCP-3142 CONTROL | |
| C-30-758 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3142<br>TO: RTU-SFL14<br>6 #14 >> FV-3142 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER AJB
REVISION 0
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-760 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3143<br>TO: FV-3143<br>7 #14 >> LCP-3143 CONTROL | |
| C-30-761 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3143<br>TO: RTU-SFL14<br>6 #14 >> FV-3143 CONTROL | |
| C-30-763 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3144<br>TO: FV-3144<br>7 #14 >> LCP-3144 CONTROL | |
| C-30-764 | 30E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3144<br>TO: RTU-SFL14<br>8 #14 >> FV-3144 CONTROL | |
| C-30-767 | 30E16 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3146<br>TO: FV-3146<br>7 #14 >> LCP-3146 CONTROL | |
| C-30-768 | 30E16 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3146<br>TO: RTU-SFL14<br>8 #14 >> FV-3146 CONTROL | |
| C-30-770 | 30E16 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3147<br>TO: RTU-SFL14<br>6 #14 >> FV-3147 CONTROL | |
| C-30-801 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3150<br>TO: RTU-NFL15<br>2 #14 >> AIT-3150 CONTROL | |
| C-30-802 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3150<br>TO: RTU-NFL15<br>2 #14 >> FSL-3150 CONTROL | |
| C-30-803 | 30E04<br>30E12 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3151<br>TO: RTU-NFL15<br>2 #14 >> AIT-3151 CONTROL | |
| C-30-804 | 30E12 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3151<br>TO: RTU-NFL15<br>8 #14 >> FV-3151 CONTROL | |
| C-30-805 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3151<br>TO: RTU-NFL15<br>2 #14 >> FIT-3151 CONTROL | |
| C-30-806 | 30E12 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3151<br>TO: RTU-NFL15<br>2 #14 >> LIT-3151 24VDC POWER | |
| C-30-807 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3152<br>TO: FV-3152<br>7 #14 >> LCP-3152 CONTROL | |
| C-30-808 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3152<br>TO: RTU-NFL15<br>6 #14 >> FV-3152 CONTROL | |
| C-30-810 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3153<br>TO: FV-3153<br>7 #14 >> LCP-3153 CONTROL | |
| C-30-811 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3153<br>TO: RTU-NFL15<br>6 #14 >> FV-3153 CONTROL | |
| C-30-813 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3154<br>TO: FV-3154<br>7 #14 >> LCP-3154 CONTROL | |
| C-30-814 | 30E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3154<br>TO: RTU-NFL15<br>8 #14 >> FV-3154 CONTROL | |
| C-30-817 | 30E12 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3156<br>TO: FV-3156<br>7 #14 >> LCP-3156 CONTROL | |
| C-30-818 | 30E12 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3156<br>TO: RTU-NFL15<br>8 #14 >> FV-3156 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-820 | 30E12 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3157<br>TO: RTU-NFL15<br>6 #14 >> FV-3157 CONTROL | |
| C-30-851 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3160<br>TO: RTU-SFL16<br>2 #14 >> AIT-3160 CONTROL | |
| C-30-852 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-3160<br>TO: RTU-SFL16<br>2 #14 >> FSL-3160 CONTROL | |
| C-30-853 | 30E04<br>30E16 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-3161<br>TO: RTU-SFL16<br>2 #14 >> AIT-3161 CONTROL | |
| C-30-854 | 30E16 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3161<br>TO: RTU-SFL16<br>8 #14 >> FV-3161 CONTROL | |
| C-30-855 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-3161<br>TO: RTU-SFL16<br>2 #14 >> FIT-3161 CONTROL | |
| C-30-856 | 30E16 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3161<br>TO: RTU-SFL16<br>2 #14 >> LIT-3161 CONTROL | |
| C-30-857 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3162<br>TO: FV-3162<br>7 #14 >> LCP-3162 CONTROL | |
| C-30-858 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3162<br>TO: RTU-SFL16<br>6 #14 >> FV-3162 CONTROL | |
| C-30-860 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3163<br>TO: FV-3163<br>7 #14 >> LCP-3163 CONTROL | |
| C-30-861 | 30E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3163<br>TO: RTU-SFL16<br>6 #14 >> FV-3163 CONTROL | |
| C-30-863 | 30E04 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3164<br>TO: FV-3164<br>7 #14 >> LCP-3164 CONTROL | |
| C-30-864 | 30E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3164<br>TO: RTU-SFL16<br>8 #14 >> FV-3164 CONTROL | |
| C-30-867 | 30E16 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-3166<br>TO: FV-3166<br>7 #14 >> LCP-3166 CONTROL | |
| C-30-868 | 30E16 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3166<br>TO: RTU-SFL16<br>8 #14 >> FV-3166 CONTROL | |
| C-30-870 | 30E16 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-3167<br>TO: RTU-SFL16<br>6 #14 >> FV-3167 CONTROL | |
| C-30-901 | 30E05 | 0.75" | 2<br>2 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-3911<br>TO: MCC-A<br>2 #12 >> MWH-3911 POWER<br>2 #14 >> TSH-3911 CONTROL | |
| C-30-902 | 30E05 | 0.75" | 2<br>2 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-3921<br>TO: MCC-A<br>2 #12 >> MWH-3921 POWER<br>2 #14 >> TSH-3921 CONTROL | |
| C-30-906 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-4051<br>TO: RTU-ELEC2C<br>6 #14 >> FV-4051 CONTROL | |
| C-30-907 | 30E06 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-4051<br>TO: FV-4051<br>7 #14 >> LCP-4051 CONTROL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| ENGINEER | AJB |
|---|---|
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-30-908 | 30E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-4061<br>TO: RTU-ELEC2C<br>6 #14 >> FV-4061 CONTROL | |
| C-30-909 | 30E06 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-4061<br>TO: FV-4061<br>7 #14 >> LCP-4061 CONTROL | |
| C-30-910 | 30E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-4135<br>TO: RTU-FBW<br>2 #14 >> FIT-4135 CONTROL POWER | |
| C-30-911 | 30E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-4136<br>TO: RTU-FBW<br>2 #14 >> FIT-4136 CONTROL POWER | |
| C-30-912 | 30E02 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-4411<br>TO: RTU-FBW<br>6 #14 >> FV-4411 CONTROL | |
| C-30-913 | 30E02 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-4411<br>TO: FV-4411<br>7 #14 >> LCP-4411 CONTROL | |
| C-30-914 | 30E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-4411<br>TO: RTU-FBW<br>2 #14 >> FIT-4411 24VDC CONTROL POWER | |
| C-30-915 | 01E04<br>01E05<br>30E03 | 1" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-4425<br>TO: RTU-BL<br>2 #14 >> LSH-4425 CONTROL | |
| C-30-916 | 01E04<br>01E05<br>30E03 | 1" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSHH-4427<br>TO: RTU-BL<br>2 #14 >> LSHH-4427 CONTROL | |
| C-30-930 | 30E13 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3001<br>TO: RTU-FBW<br>2 #14 >> LIT-3001 CONTROL POWER | |
| C-30-932 | 30E17 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LIT-3002<br>TO: RTU-FBW<br>2 #14 >> LIT-3002 CONTROL | |
| C-30-951 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSHH-3931<br>TO: RTU-FBW<br>2 #14 >> LSHH-3931 STATUS | |
| C-30-952 | 30E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-3942<br>TO: RTU-FBW<br>2 #14 >> FSH-3942 STATUS | |
| L-30-005 | 30E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: RTU-BL<br>TO: UPS-S<br>2 #12 >> RTU-BL POWER | |
| L-30-691 | 30E19 | 1" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SECURITY PANEL<br>TO: PNL-B1<br>2 #12 >> SECURITY PANEL POWER | |
| L-30-695 | 30E19 | 1" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SECURITY PANEL<br>TO: UPS-B<br>2 #12 >> SECURITY PANEL POWER | |
| L-30-696 | 30E19 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LOI-FB<br>TO: UPS-B<br>2 #12 >> LOI-FB POWER | |
| L-30-950 | 30E05 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-3931<br>TO: PANELBOARD FGA, CKT 5<br>2 #12 >> PMP-3931 POWER | |
| L-30-951 | 30E05 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-3941<br>TO: PANELBOARD FGA, CKT 7<br>2 #12 >> PMP-3941 POWER | |
| N-30-005 | 30E03 | 2" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: RTU-BL<br>TO: LEVEL 2 NETWORK ROOM<br>1 12/FO >> RTU-BL NETWORK | |
| N-30-010 | 30E03 | 0.75" | 1 | | CAT5E | 1 | #14 | XHHW-2 | FR: MCC-BL<br>TO: RTU-BL<br>1 CAT5E >> MCC-BL NETWORK | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| N-30-101 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3010<br>TO: RTU-NFL1<br>1 CAT6 >> AIT-3010 NETWORK | |
| N-30-102 | 30E06 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3011<br>TO: RTU-NFL1<br>1 RS-485 >> FIT-3011 NETWORK | |
| N-30-103 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3019<br>TO: RTU-NFL1<br>1 CAT6 >> AIT-3019 NETWORK | |
| N-30-151 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3020<br>TO: RTU-SFL2<br>1 CAT6 >> AIT-3020 NETWORK | |
| N-30-152 | 30E06 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3021<br>TO: RTU-SFL2<br>1 RS-485 >> FIT-3021 NETWORK | |
| N-30-153 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3029<br>TO: RTU-SFL2<br>1 CAT6 >> AIT-3029 NETWORK | |
| N-30-201 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3030<br>TO: RTU-NFL3<br>1 CAT6 >> AIT-3030 NETWORK | |
| N-30-202 | 30E07 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3031<br>TO: RTU-NFL3<br>1 RS-485 >> FIT-3031 NETWORK | |
| N-30-203 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3039<br>TO: RTU-NFL3<br>1 CAT6 >> AIT-3039 NETWORK | |
| N-30-251 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3040<br>TO: RTU-SFL4<br>1 CAT6 >> AIT-3040 NETWORK | |
| N-30-252 | 30E07 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3041<br>TO: RTU-SFL4<br>1 RS-485 >> FIT-3041 NETWORK | |
| N-30-253 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3049<br>TO: RTU-SFL4<br>1 CAT6 >> AIT-3049 NETWORK | |
| N-30-301 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3050<br>TO: RTU-NFL5<br>1 CAT6 >> AIT-3050 NETWORK | |
| N-30-302 | 30E07 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3051<br>TO: RTU-NFL5<br>1 RS-485 >> FIT-3051 NETWORK | |
| N-30-303 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3059<br>TO: RTU-NFL5<br>1 CAT6 >> AIT-3059 NETWORK | |
| N-30-351 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3060<br>TO: RTU-SFL6<br>1 CAT6 >> AIT-3060 NETWORK | |
| N-30-352 | 30E07 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3061<br>TO: RTU-SFL6<br>1 RS-485 >> FIT-3061 NETWORK | |
| N-30-353 | 30E06 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3069<br>TO: RTU-SFL6<br>1 CAT6 >> AIT-3069 NETWORK | |
| N-30-401 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3070<br>TO: RTU-NFL7<br>1 CAT6 >> AIT-3070 NETWORK | |
| N-30-402 | 30E05 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3071<br>TO: RTU-NFL7<br>1 RS-485 >> FIT-3071 NETWORK | |
| N-30-403 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3079<br>TO: RTU-NFL7<br>1 CAT6 >> AIT-3079 NETWORK | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| N-30-451 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3080<br>TO: RTU-SFL8<br>1 CAT6 >> AIT-3080 NETWORK | |
| N-30-452 | 30E05 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3081<br>TO: RTU-SFL8<br>1 RS-485 >> FIT-3081 NETWORK | |
| N-30-453 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3089<br>TO: RTU-SFL8<br>1 CAT6 >> AIT-3089 NETWORK | |
| N-30-501 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3090<br>TO: RTU-NFL9<br>1 CAT6 >> AIT-3090 NETWORK | |
| N-30-502 | 30E05 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3091<br>TO: RTU-NFL9<br>1 RS-485 >> FIT-3091 NETWORK | |
| N-30-503 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3099<br>TO: RTU-NFL9<br>1 CAT6 >> AIT-3099 NETWORK | |
| N-30-551 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3100<br>TO: RTU-SFL10<br>1 CAT6 >> AIT-3100 NETWORK | |
| N-30-552 | 30E05 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3101<br>TO: RTU-SFL10<br>1 RS-485 >> FIT-3101 NETWORK | |
| N-30-553 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3109<br>TO: RTU-SFL10<br>1 CAT6 >> AIT-3109 NETWORK | |
| N-30-601 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3110<br>TO: RTU-NFL11<br>1 CAT6 >> AIT-3110 NETWORK | |
| N-30-602 | 30E05 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3111<br>TO: RTU-NFL11<br>1 RS-485 >> FIT-3111 NETWORK | |
| N-30-603 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3119<br>TO: RTU-NFL11<br>1 CAT6 >> AIT-3119 NETWORK | |
| N-30-651 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3120<br>TO: RTU-SFL12<br>1 CAT6 >> AIT-3120 NETWORK | |
| N-30-652 | 30E05 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3121<br>TO: RTU-SFL12<br>1 RS-485 >> FIT-3121 NETWORK | |
| N-30-653 | 30E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3129<br>TO: RTU-SFL12<br>1 CAT6 >> AIT-3129 NETWORK | |
| N-30-691 | 30E19 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY PANEL<br>TO: NETWORK RACK<br>1 PULL >> SPARE | |
| N-30-695 | 30E19 | 1" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: LOI-FB<br>TO: NETWORK ROOM FIBER PATCH PANEL<br>1 CAT6 >> LOI-FB NETWORK | |
| N-30-701 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3130<br>TO: RTU-NFL13<br>1 CAT6 >> AIT-3130 NETWORK | |
| N-30-702 | 30E04 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3131<br>TO: RTU-NFL13<br>1 RS-485 >> FIT-3131 NETWORK | |
| N-30-703 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3139<br>TO: RTU-NFL13<br>1 CAT6 >> AIT-3139 NETWORK | |
| N-30-751 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3140<br>TO: RTU-SFL14<br>1 CAT6 >> AIT-3140 NETWORK | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| N-30-752 | 30E04 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3141<br>TO: RTU-SFL14<br>1 RS-485 >> FIT-3141 NETWORK | |
| N-30-753 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3149<br>TO: RTU-SFL14<br>1 CAT6 >> AIT-3149 NETWORK | |
| N-30-801 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3150<br>TO: RTU-NFL15<br>1 CAT6 >> AIT-3150 NETWORK | |
| N-30-802 | 30E04 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3151<br>TO: RTU-NFL15<br>1 RS-485 >> FIT-3151 NETWORK | |
| N-30-803 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3159<br>TO: RTU-NFL15<br>1 CAT6 >> AIT-3159 NETWORK | |
| N-30-851 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3160<br>TO: RTU-SFL16<br>1 CAT6 >> AIT-3160 NETWORK | |
| N-30-852 | 30E04 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-3161<br>TO: RTU-SFL16<br>1 RS-485 >> FIT-3161 NETWORK | |
| N-30-853 | 30E04 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: AIT-3169<br>TO: RTU-SFL16<br>1 CAT6 >> AIT-3169 NETWORK | |
| N-30-902 | 30E04 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-4135<br>TO: RTU-FBW<br>1 RS-485 >> FIT-4135 MBRTU | |
| N-30-904 | 30E02 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-4411<br>TO: RTU-FBW<br>1 RS-485 >> FIT-4411 NETWORK | |
| P-30-011 | 30E03 | 3" | 3<br>2<br>2 | 300<br>#12<br>#14 | XHHW-2<br>XHHW-2<br>XHHW-2 | 1 | #1/0 | XHHW-2 | FR: BLO-4201<br>TO: MCC-BL<br>3 300 >> BLO-4201 POWER<br>2 #12 >> BLO-4201 MWH POWER<br>2 #14 >> BLO-4201 TSH CONTROL | |
| P-30-012 | 30E03 | 3" | 3 | 300 | XHHW-2 | 1 | #1/0 | XHHW-2 | FR: BLO-4201<br>TO: MCC-BL<br>3 300 >> BLO-4201 POWER | |
| P-30-021 | 30E03 | 3" | 3<br>2<br>2 | 300<br>#12<br>#14 | XHHW-2<br>XHHW-2<br>XHHW-2 | 1 | #1/0 | XHHW-2 | FR: BLO-4211<br>TO: MCC-BL<br>3 300 >> BLO-4211 POWER<br>2 #12 >> BLO-4211 MWH POWER<br>2 #14 >> BLO-4211 TSH CONTROL | |
| P-30-022 | 30E03 | 3" | 3 | 300 | XHHW-2 | 1 | #1/0 | XHHW-2 | FR: BLO-4211<br>TO: MCC-BL<br>3 300 >> BLO-4211 POWER | |
| P-30-101 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3011<br>TO: FV-3011<br>3 #12 >> FV-3011 POWER | |
| P-30-102 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3012<br>TO: FV-3012<br>3 #12 >> FV-3012 POWER | |
| P-30-103 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3013<br>TO: FV-3013<br>3 #12 >> FV-3013 POWER | |
| P-30-104 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3014<br>TO: FV-3014<br>3 #12 >> FV-3014 POWER | |
| P-30-106 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3016<br>TO: FV-3016<br>3 #12 >> FV-3016 POWER | |
| P-30-107 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3017<br>TO: FV-3017<br>3 #12 >> FV-3017 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-111 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3011<br>TO: PP-6<br>3 #12 >> DISC-3011 POWER | |
| P-30-112 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3012<br>TO: PP-6<br>3 #12 >> DISC-3012 POWER | |
| P-30-113 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3013<br>TO: PP-6<br>3 #12 >> DISC-3013 POWER | |
| P-30-114 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3014<br>TO: PP-6<br>3 #12 >> DISC-3014 POWER | |
| P-30-116 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3016<br>TO: PP-6<br>3 #12 >> DISC-3016 POWER | |
| P-30-117 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3017<br>TO: PP-6<br>3 #12 >> DISC-3017 POWER | |
| P-30-151 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3021<br>TO: FV-3021<br>3 #12 >> FV-3021 POWER | |
| P-30-152 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3022<br>TO: FV-3022<br>3 #12 >> FV-3022 POWER | |
| P-30-153 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3023<br>TO: FV-3023<br>3 #12 >> FV-3023 POWER | |
| P-30-154 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3024<br>TO: FV-3024<br>3 #12 >> FV-3024 POWER | |
| P-30-156 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3026<br>TO: FV-3026<br>3 #12 >> FV-3026 POWER | |
| P-30-157 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3027<br>TO: FV-3027<br>3 #12 >> FV-3027 POWER | |
| P-30-161 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3021<br>TO: PP-6<br>3 #12 >> DISC-3021 POWER | |
| P-30-162 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3022<br>TO: PP-6<br>3 #12 >> DISC-3022 POWER | |
| P-30-163 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3023<br>TO: PP-6<br>3 #12 >> DISC-3023 POWER | |
| P-30-164 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3024<br>TO: PP-6<br>3 #12 >> DISC-3024 POWER | |
| P-30-166 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3026<br>TO: PP-6<br>3 #12 >> DISC-3026 POWER | |
| P-30-167 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3027<br>TO: PP-6<br>3 #12 >> DISC-3027 POWER | |
| P-30-201 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3031<br>TO: FV-3031<br>3 #12 >> FV-3031 POWER | |
| P-30-202 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3032<br>TO: FV-3032<br>3 #12 >> FV-3032 POWER | |
| P-30-203 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3033<br>TO: FV-3033<br>3 #12 >> FV-3033 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-204 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3034<br>TO: FV-3034<br>3 #12 >> FV-3034 POWER | |
| P-30-206 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3036<br>TO: FV-3036<br>3 #12 >> FV-3036 POWER | |
| P-30-207 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3037<br>TO: FV-3037<br>3 #12 >> FV-3037 POWER | |
| P-30-211 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3031<br>TO: PP-7<br>3 #12 >> DISC-3031 POWER | |
| P-30-212 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3032<br>TO: PP-7<br>3 #12 >> DISC-3032 POWER | |
| P-30-213 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3033<br>TO: PP-7<br>3 #12 >> DISC-3033 POWER | |
| P-30-214 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3034<br>TO: PP-7<br>3 #12 >> DISC-3034 POWER | |
| P-30-216 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3036<br>TO: PP-7<br>3 #12 >> DISC-3036 POWER | |
| P-30-217 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3037<br>TO: PP-7<br>3 #12 >> DISC-3037 POWER | |
| P-30-251 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3041<br>TO: FV-3041<br>3 #12 >> FV-3041 POWER | |
| P-30-252 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3042<br>TO: FV-3042<br>3 #12 >> FV-3042 POWER | |
| P-30-253 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3043<br>TO: FV-3043<br>3 #12 >> FV-3043 POWER | |
| P-30-254 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3044<br>TO: FV-3044<br>3 #12 >> FV-3044 POWER | |
| P-30-256 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3046<br>TO: FV-3046<br>3 #12 >> FV-3046 POWER | |
| P-30-257 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3047<br>TO: FV-3047<br>3 #12 >> FV-3047 POWER | |
| P-30-261 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3041<br>TO: PP-7<br>3 #12 >> DISC-3041 POWER | |
| P-30-262 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3042<br>TO: PP-7<br>3 #12 >> DISC-3042 POWER | |
| P-30-263 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3043<br>TO: PP-7<br>3 #12 >> DISC-3043 POWER | |
| P-30-264 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3044<br>TO: PP-7<br>3 #12 >> DISC-3044 POWER | |
| P-30-266 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3046<br>TO: PP-7<br>3 #12 >> DISC-3046 POWER | |
| P-30-267 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3047<br>TO: PP-7<br>3 #12 >> DISC-3047 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-301 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3051<br>TO: FV-3051<br>3 #12 >> FV-3051 POWER | |
| P-30-302 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3052<br>TO: FV-3052<br>3 #12 >> FV-3052 POWER | |
| P-30-303 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3053<br>TO: FV-3053<br>3 #12 >> FV-3053 POWER | |
| P-30-304 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3054<br>TO: FV-3054<br>3 #12 >> FV-3054 POWER | |
| P-30-306 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3056<br>TO: FV-3056<br>3 #12 >> FV-3056 POWER | |
| P-30-307 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3057<br>TO: FV-3057<br>3 #12 >> FV-3057 POWER | |
| P-30-311 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3051<br>TO: PP-8<br>3 #12 >> DISC-3051 POWER | |
| P-30-312 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3052<br>TO: PP-8<br>3 #12 >> DISC-3052 POWER | |
| P-30-313 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3053<br>TO: PP-8<br>3 #12 >> DISC-3053 POWER | |
| P-30-314 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3054<br>TO: PP-8<br>3 #12 >> DISC-3054 POWER | |
| P-30-316 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3056<br>TO: PP-8<br>3 #12 >> DISC-3056 POWER | |
| P-30-317 | 30E14 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3057<br>TO: PP-8<br>3 #12 >> DISC-3057 POWER | |
| P-30-351 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3061<br>TO: FV-3061<br>3 #12 >> FV-3061 POWER | |
| P-30-352 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3062<br>TO: FV-3062<br>3 #12 >> FV-3062 POWER | |
| P-30-353 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3063<br>TO: FV-3063<br>3 #12 >> FV-3063 POWER | |
| P-30-354 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3064<br>TO: FV-3064<br>3 #12 >> FV-3064 POWER | |
| P-30-356 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3066<br>TO: FV-3066<br>3 #12 >> FV-3066 POWER | |
| P-30-357 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3067<br>TO: FV-3067<br>3 #12 >> FV-3067 POWER | |
| P-30-361 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3061<br>TO: PP-8<br>3 #12 >> DISC-3061 POWER | |
| P-30-362 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3062<br>TO: PP-8<br>3 #12 >> DISC-3062 POWER | |
| P-30-363 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3063<br>TO: PP-8<br>3 #12 >> DISC-3063 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-364 | 30E07 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3064<br>TO: PP-8<br>3 #12 >> DISC-3064 POWER | |
| P-30-366 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3066<br>TO: PP-8<br>3 #12 >> DISC-3066 POWER | |
| P-30-367 | 30E18 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3067<br>TO: PP-8<br>3 #12 >> DISC-3067 POWER | |
| P-30-401 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3071<br>TO: FV-3071<br>3 #12 >> FV-3071 POWER | |
| P-30-402 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3072<br>TO: FV-3072<br>3 #12 >> FV-3072 POWER | |
| P-30-403 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3073<br>TO: FV-3073<br>3 #12 >> FV-3073 POWER | |
| P-30-404 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3074<br>TO: FV-3074<br>3 #12 >> FV-3074 POWER | |
| P-30-406 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3076<br>TO: FV-3076<br>3 #12 >> FV-3076 POWER | |
| P-30-407 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3077<br>TO: FV-3077<br>3 #12 >> FV-3077 POWER | |
| P-30-411 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3071<br>TO: PP-1<br>3 #12 >> DISC-3071 POWER | |
| P-30-412 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3072<br>TO: PP-1<br>3 #12 >> DISC-3072 POWER | |
| P-30-413 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3073<br>TO: PP-1<br>3 #12 >> DISC-3073 POWER | |
| P-30-414 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3074<br>TO: PP-1<br>3 #12 >> DISC-3074 POWER | |
| P-30-416 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3076<br>TO: PP-1<br>3 #12 >> DISC-3076 POWER | |
| P-30-417 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3077<br>TO: PP-1<br>3 #12 >> DISC-3077 POWER | |
| P-30-451 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3081<br>TO: FV-3081<br>3 #12 >> FV-3081 POWER | |
| P-30-452 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3082<br>TO: FV-3082<br>3 #12 >> FV-3082 POWER | |
| P-30-453 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3083<br>TO: FV-3083<br>3 #12 >> FV-3083 POWER | |
| P-30-454 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3084<br>TO: FV-3084<br>3 #12 >> FV-3084 POWER | |
| P-30-456 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3086<br>TO: FV-3086<br>3 #12 >> FV-3086 POWER | |
| P-30-457 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3087<br>TO: FV-3087<br>3 #12 >> FV-3087 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-461 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3081<br>TO: PP-1<br>3 #12 >> DISC-3081 POWER | |
| P-30-462 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3082<br>TO: PP-1<br>3 #12 >> DISC-3082 POWER | |
| P-30-463 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3083<br>TO: PP-1<br>3 #12 >> DISC-3083 POWER | |
| P-30-464 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3084<br>TO: PP-1<br>3 #12 >> DISC-3084 POWER | |
| P-30-466 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3086<br>TO: PP-1<br>3 #12 >> DISC-3086 POWER | |
| P-30-467 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3087<br>TO: PP-1<br>3 #12 >> DISC-3087 POWER | |
| P-30-501 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3091<br>TO: FV-3091<br>3 #12 >> FV-3091 POWER | |
| P-30-502 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3092<br>TO: FV-3092<br>3 #12 >> FV-3092 POWER | |
| P-30-503 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3093<br>TO: FV-3093<br>3 #12 >> FV-3093 POWER | |
| P-30-504 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3094<br>TO: FV-3094<br>3 #12 >> FV-3094 POWER | |
| P-30-506 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3096<br>TO: FV-3096<br>3 #12 >> FV-3096 POWER | |
| P-30-507 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3097<br>TO: FV-3097<br>3 #12 >> FV-3097 POWER | |
| P-30-511 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3091<br>TO: PP-2<br>3 #12 >> DISC-3091 POWER | |
| P-30-512 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3092<br>TO: PP-2<br>3 #12 >> DISC-3092 POWER | |
| P-30-513 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3093<br>TO: PP-2<br>3 #12 >> DISC-3093 POWER | |
| P-30-514 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3094<br>TO: PP-2<br>3 #12 >> DISC-3094 POWER | |
| P-30-516 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3096<br>TO: PP-2<br>3 #12 >> DISC-3096 POWER | |
| P-30-517 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3097<br>TO: PP-2<br>3 #12 >> DISC-3097 POWER | |
| P-30-551 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3101<br>TO: FV-3101<br>3 #12 >> FV-3101 POWER | |
| P-30-552 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3102<br>TO: FV-3102<br>3 #12 >> FV-3102 POWER | |
| P-30-553 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3103<br>TO: FV-3103<br>3 #12 >> FV-3103 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-554 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3104<br>TO: FV-3104<br>3 #12 >> FV-3104 POWER | |
| P-30-556 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3106<br>TO: FV-3106<br>3 #12 >> FV-3106 POWER | |
| P-30-557 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3107<br>TO: FV-3107<br>3 #12 >> FV-3107 POWER | |
| P-30-561 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3101<br>TO: PP-2<br>3 #12 >> DISC-3101 POWER | |
| P-30-562 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3102<br>TO: PP-2<br>3 #12 >> DISC-3102 POWER | |
| P-30-563 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3103<br>TO: PP-2<br>3 #12 >> DISC-3103 POWER | |
| P-30-564 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3104<br>TO: PP-2<br>3 #12 >> DISC-3104 POWER | |
| P-30-566 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3106<br>TO: PP-2<br>3 #12 >> DISC-3106 POWER | |
| P-30-567 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3107<br>TO: PP-2<br>3 #12 >> DISC-3107 POWER | |
| P-30-601 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3111<br>TO: FV-3111<br>3 #12 >> FV-3111 POWER | |
| P-30-602 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3112<br>TO: FV-3112<br>3 #12 >> FV-3112 POWER | |
| P-30-603 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3113<br>TO: FV-3113<br>3 #12 >> FV-3113 POWER | |
| P-30-604 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3114<br>TO: FV-3114<br>3 #12 >> FV-3114 POWER | |
| P-30-606 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3116<br>TO: FV-3116<br>3 #12 >> FV-3116 POWER | |
| P-30-607 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3117<br>TO: FV-3117<br>3 #12 >> FV-3117 POWER | |
| P-30-611 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3111<br>TO: PP-3<br>3 #12 >> DISC-3111 POWER | |
| P-30-612 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3112<br>TO: PP-3<br>3 #12 >> DISC-3112 POWER | |
| P-30-613 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3113<br>TO: PP-3<br>3 #12 >> DISC-3113 POWER | |
| P-30-614 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3114<br>TO: PP-3<br>3 #12 >> DISC-3114 POWER | |
| P-30-616 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3116<br>TO: PP-3<br>3 #12 >> DISC-3116 POWER | |
| P-30-617 | 30E13 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3117<br>TO: PP-3<br>3 #12 >> DISC-3117 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER AJB
REVISION 0
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-651 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3121<br>TO: FV-3121<br>3 #12 >> FV-3121 POWER | |
| P-30-652 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3122<br>TO: FV-3122<br>3 #12 >> FV-3122 POWER | |
| P-30-653 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3123<br>TO: FV-3123<br>3 #12 >> FV-3123 POWER | |
| P-30-654 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3124<br>TO: FV-3124<br>3 #12 >> FV-3124 POWER | |
| P-30-656 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3126<br>TO: FV-3126<br>3 #12 >> FV-3126 POWER | |
| P-30-657 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3127<br>TO: FV-3127<br>3 #12 >> FV-3127 POWER | |
| P-30-661 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3121<br>TO: PP-3<br>3 #12 >> DISC-3121 POWER | |
| P-30-662 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3122<br>TO: PP-3<br>3 #12 >> DISC-3122 POWER | |
| P-30-663 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3123<br>TO: PP-3<br>3 #12 >> DISC-3123 POWER | |
| P-30-664 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3124<br>TO: PP-3<br>3 #12 >> DISC-3124 POWER | |
| P-30-666 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3126<br>TO: PP-3<br>3 #12 >> DISC-3126 POWER | |
| P-30-667 | 30E17 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3127<br>TO: PP-3<br>3 #12 >> DISC-3127 POWER | |
| P-30-701 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3131<br>TO: FV-3131<br>3 #12 >> FV-3131 POWER | |
| P-30-702 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3132<br>TO: FV-3132<br>3 #12 >> FV-3132 POWER | |
| P-30-703 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3133<br>TO: FV-3133<br>3 #12 >> FV-3133 POWER | |
| P-30-704 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3134<br>TO: FV-3134<br>3 #12 >> FV-3134 POWER | |
| P-30-706 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3136<br>TO: FV-3136<br>3 #12 >> FV-3136 POWER | |
| P-30-707 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3137<br>TO: FV-3137<br>3 #12 >> FV-3137 POWER | |
| P-30-711 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3131<br>TO: PP-4<br>3 #12 >> DISC-3131 POWER | |
| P-30-712 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3132<br>TO: PP-4<br>3 #12 >> DISC-3132 POWER | |
| P-30-713 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3133<br>TO: PP-4<br>3 #12 >> DISC-3133 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-714 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3134<br>TO: PP-4<br>3 #12 >> DISC-3134 POWER | |
| P-30-716 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3136<br>TO: PP-4<br>3 #12 >> DISC-3136 POWER | |
| P-30-717 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3137<br>TO: PP-4<br>3 #12 >> DISC-3137 POWER | |
| P-30-751 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3141<br>TO: FV-3141<br>3 #12 >> FV-3141 POWER | |
| P-30-752 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3142<br>TO: FV-3142<br>3 #12 >> FV-3142 POWER | |
| P-30-753 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3143<br>TO: FV-3143<br>3 #12 >> FV-3143 POWER | |
| P-30-754 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3144<br>TO: FV-3144<br>3 #12 >> FV-3144 POWER | |
| P-30-756 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3146<br>TO: FV-3146<br>3 #12 >> FV-3146 POWER | |
| P-30-757 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3147<br>TO: FV-3147<br>3 #12 >> FV-3147 POWER | |
| P-30-761 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3141<br>TO: PP-4<br>3 #12 >> DISC-3141 POWER | |
| P-30-762 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3142<br>TO: PP-4<br>3 #12 >> DISC-3142 POWER | |
| P-30-763 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3143<br>TO: PP-4<br>3 #12 >> DISC-3143 POWER | |
| P-30-764 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3144<br>TO: PP-4<br>3 #12 >> DISC-3144 POWER | |
| P-30-766 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3146<br>TO: PP-4<br>3 #12 >> DISC-3146 POWER | |
| P-30-767 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3147<br>TO: PP-4<br>3 #12 >> DISC-3147 POWER | |
| P-30-801 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3151<br>TO: FV-3151<br>3 #12 >> FV-3151 POWER | |
| P-30-802 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3152<br>TO: FV-3152<br>3 #12 >> FV-3152 POWER | |
| P-30-803 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3153<br>TO: FV-3153<br>3 #12 >> FV-3153 POWER | |
| P-30-804 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3154<br>TO: FV-3154<br>3 #12 >> FV-3154 POWER | |
| P-30-806 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3156<br>TO: FV-3156<br>3 #12 >> FV-3156 POWER | |
| P-30-807 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3157<br>TO: FV-3157<br>3 #12 >> FV-3157 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-811 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3151<br>TO: PP-5<br>3 #12 >> DISC-3151 POWER | |
| P-30-812 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3152<br>TO: PP-5<br>3 #12 >> DISC-3152 POWER | |
| P-30-813 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3153<br>TO: PP-5<br>3 #12 >> DISC-3153 POWER | |
| P-30-814 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3154<br>TO: PP-5<br>3 #12 >> DISC-3154 POWER | |
| P-30-816 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3156<br>TO: PP-5<br>3 #12 >> DISC-3156 POWER | |
| P-30-817 | 30E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3157<br>TO: PP-5<br>3 #12 >> DISC-3157 POWER | |
| P-30-851 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3161<br>TO: FV-3161<br>3 #12 >> FV-3161 POWER | |
| P-30-852 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3162<br>TO: FV-3162<br>3 #12 >> FV-3162 POWER | |
| P-30-853 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3163<br>TO: FV-3163<br>3 #12 >> FV-3163 POWER | |
| P-30-854 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3164<br>TO: FV-3164<br>3 #12 >> FV-3164 POWER | |
| P-30-856 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3166<br>TO: FV-3166<br>3 #12 >> FV-3166 POWER | |
| P-30-857 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3167<br>TO: FV-3167<br>3 #12 >> FV-3167 POWER | |
| P-30-861 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3161<br>TO: PP-5<br>3 #12 >> DISC-3161 POWER | |
| P-30-862 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3162<br>TO: PP-5<br>3 #12 >> DISC-3162 POWER | |
| P-30-863 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3163<br>TO: PP-5<br>3 #12 >> DISC-3163 POWER | |
| P-30-864 | 30E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3164<br>TO: PP-5<br>3 #12 >> DISC-3164 POWER | |
| P-30-866 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3166<br>TO: PP-5<br>3 #12 >> DISC-3166 POWER | |
| P-30-867 | 30E16 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-3167<br>TO: PP-5<br>3 #12 >> DISC-3167 POWER | |
| P-30-901 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-3911<br>TO: MCC-A<br>3 #12 >> PMP-3911 POWER | |
| P-30-902 | 30E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-3921<br>TO: MCC-A<br>3 #12 >> PMP-3921 POWER | |
| P-30-904 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4051<br>TO: FV-4051<br>3 #12 >> FV-4051 POWER | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-30-905 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4061<br>TO: FV-4061<br>3 #12 >> FV-4061 POWER | |
| P-30-906 | 30E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4411<br>TO: FV-4411<br>2 #12 >> FV-4411 POWER | |
| P-30-914 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4051<br>TO: PP-CL<br>3 #12 >> DISC-4051 POWER | |
| P-30-915 | 30E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4061<br>TO: PP-CL<br>3 #12 >> DISC-4061 POWER | |
| P-30-916 | 30E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4411<br>TO: MCC-A<br>2 #12 >> DISC-4411 POWER | |
| S-30-102 | 30E06 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3011<br>TO: FIT-3011<br>1 MFR >> FE-3011 SIGNAL | |
| S-30-103 | 30E14 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3011<br>TO: LIT-3011<br>1 MFR >> LE-3011 SIGNAL | |
| S-30-104 | 30E14 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3011<br>TO: RTU-NFL1<br>1 2/CS-#16 >> LIT-3011 SIGNAL | |
| S-30-105 | 30E14 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3011<br>TO: RTU-NFL1<br>2 2/CS-#16 >> FV-3011 SIGNAL | |
| S-30-106 | 30E06 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3011<br>TO: RTU-NFL1<br>1 2/CS-#16 >> PIT-3011 SIGNAL | |
| S-30-107 | 30E07 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3012<br>TO: RTU-NFL1<br>2 2/CS-#16 >> FV-3012 SIGNAL | |
| S-30-108 | 30E06 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3013<br>TO: RTU-NFL1<br>2 2/CS-#16 >> FV-3013 SIGNAL | |
| S-30-110 | 30E14 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3011<br>TO: AIT-3011<br>1 MFR >> AE-3011 SIGNAL | |
| S-30-111 | 30E14 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3011<br>TO: RTU-NFL1<br>1 2/CS-#16 >> AIT-3011 SIGNAL | |
| S-30-112 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3010<br>TO: AIT-3010<br>1 MFR >> AE-3010 SIGNAL | |
| S-30-113 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3019<br>TO: AIT-3019<br>1 MFR >> AE-3019 SIGNAL | |
| S-30-152 | 30E06 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3021<br>TO: FIT-3021<br>1 MFR >> FE-3021 SIGNAL | |
| S-30-153 | 30E18 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3021<br>TO: LIT-3021<br>1 MFR >> LE-3021 SIGNAL | |
| S-30-154 | 30E18 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3021<br>TO: RTU-SFL2<br>1 2/CS-#16 >> LIT-3021 SIGNAL | |
| S-30-155 | 30E18 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3021<br>TO: RTU-SFL2<br>2 2/CS-#16 >> FV-3021 SIGNAL | |
| S-30-156 | 30E06 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3021<br>TO: RTU-SFL2<br>1 2/CS-#16 >> PIT-3021 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-157 | 30E07 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3022<br>TO: RTU-SFL2<br>2 2/CS-#16 >> FV-3022 SIGNAL | |
| S-30-158 | 30E06 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3023<br>TO: RTU-SFL2<br>2 2/CS-#16 >> FV-3023 SIGNAL | |
| S-30-160 | 30E18 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3021<br>TO: AIT-3021<br>1 MFR >> AE-3021 SIGNAL | |
| S-30-161 | 30E18 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3021<br>TO: RTU-SFL2<br>2 2/CS-#16 >> AIT-3021 SIGNAL | |
| S-30-162 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3020<br>TO: AIT-3020<br>1 MFR >> AE-3020 SIGNAL | |
| S-30-163 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3029<br>TO: AIT-3029<br>1 MFR >> AE-3029 SIGNAL | |
| S-30-202 | 30E06 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3031<br>TO: FIT-3031<br>1 MFR >> FE-3031 SIGNAL | |
| S-30-203 | 30E14 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3031<br>TO: LIT-3031<br>1 MFR >> LE-3031 SIGNAL | |
| S-30-204 | 30E14 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3031<br>TO: RTU-NFL3<br>1 2/CS-#16 >> LIT-3031 SIGNAL | |
| S-30-205 | 30E14 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3031<br>TO: RTU-NFL3<br>2 2/CS-#16 >> FV-3031 SIGNAL | |
| S-30-206 | 30E06 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3031<br>TO: RTU-NFL3<br>2 2/CS-#16 >> PIT-3031 SIGNAL | |
| S-30-207 | 30E07 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3032<br>TO: RTU-NFL3<br>2 2/CS-#16 >> FV-3032 SIGNAL | |
| S-30-208 | 30E06 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3033<br>TO: RTU-NFL3<br>2 2/CS-#16 >> FV-3033 SIGNAL | |
| S-30-210 | 30E14 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3031<br>TO: AIT-3031<br>1 MFR >> AE-3031 SIGNAL | |
| S-30-211 | 30E14 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3031<br>TO: RTU-NFL3<br>1 2/CS-#16 >> AIT-3031 SIGNAL | |
| S-30-212 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3030<br>TO: AIT-3030<br>1 MFR >> AE-3030 SIGNAL | |
| S-30-213 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3039<br>TO: AIT-3039<br>1 MFR >> AE-3039 SIGNAL | |
| S-30-252 | 30E06 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3041<br>TO: FIT-3041<br>1 MFR >> FE-3041 SIGNAL | |
| S-30-253 | 30E18 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3041<br>TO: LIT-3041<br>1 MFR >> LE-3041 SIGNAL | |
| S-30-254 | 30E18 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3041<br>TO: RTU-SFL4<br>1 2/CS-#16 >> LIT-3041 SIGNAL | |
| S-30-255 | 30E18 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3041<br>TO: RTU-SFL4<br>2 2/CS-#16 >> FV-3041 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-256 | 30E06 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3041<br>TO: RTU-SFL4<br>1 2/CS-#16 >> PIT-3041 SIGNAL | |
| S-30-257 | 30E07 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3042<br>TO: RTU-SFL4<br>1 2/CS-#16 >> FV-3042 SIGNAL | |
| S-30-258 | 30E06 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3043<br>TO: RTU-SFL4<br>2 2/CS-#16 >> FV-3043 SIGNAL | |
| S-30-260 | 30E18 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3041<br>TO: AIT-3041<br>1 MFR >> AE-3041 SIGNAL | |
| S-30-261 | 30E18 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3041<br>TO: RTU-SFL4<br>1 2/CS-#16 >> AIT-3041 SIGNAL | |
| S-30-262 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3040<br>TO: AIT-3040<br>1 MFR >> AE-3040 SIGNAL | |
| S-30-263 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3049<br>TO: AIT-3049<br>1 MFR >> AE-3049 SIGNAL | |
| S-30-302 | 30E06 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3051<br>TO: FIT-3051<br>1 MFR >> FE-3051 SIGNAL | |
| S-30-303 | 30E14 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3051<br>TO: LIT-3051<br>1 MFR >> LE-3051 SIGNAL | |
| S-30-304 | 30E14 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3051<br>TO: RTU-NFL5<br>1 2/CS-#16 >> LIT-3051 SIGNAL | |
| S-30-305 | 30E14 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3051<br>TO: RTU-NFL5<br>2 2/CS-#16 >> FV-3051 SIGNAL | |
| S-30-306 | 30E06 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3051<br>TO: RTU-NFL5<br>1 2/CS-#16 >> PIT-3051 SIGNAL | |
| S-30-307 | 30E07 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3052<br>TO: RTU-NFL5<br>2 2/CS-#16 >> FV-3052 SIGNAL | |
| S-30-308 | 30E06 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3053<br>TO: RTU-NFL5<br>2 2/CS-#16 >> FV-3053 SIGNAL | |
| S-30-310 | 30E14 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3051<br>TO: AIT-3051<br>1 MFR >> AE-3051 SIGNAL | |
| S-30-311 | 30E14 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3051<br>TO: RTU-NFL5<br>1 2/CS-#16 >> AIT-3051 SIGNAL | |
| S-30-312 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3050<br>TO: AIT-3050<br>1 MFR >> AE-3050 SIGNAL | |
| S-30-313 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3059<br>TO: AIT-3059<br>1 MFR >> AE-3059 SIGNAL | |
| S-30-352 | 30E06 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3061<br>TO: FIT-3061<br>1 MFR >> FE-3061 SIGNAL | |
| S-30-353 | 30E18 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3061<br>TO: LIT-3061<br>1 MFR >> LE-3061 SIGNAL | |
| S-30-354 | 30E18 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3061<br>TO: RTU-SFL6<br>1 2/CS-#16 >> LIT-3061 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-355 | 30E18 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3061<br>TO: RTU-SFL6<br>2 2/CS-#16 >> FV-3061 SIGNAL | |
| S-30-356 | 30E06 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3061<br>TO: RTU-SFL6<br>1 2/CS-#16 >> PIT-3061 SIGNAL | |
| S-30-357 | 30E07 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3062<br>TO: RTU-SFL6<br>2 2/CS-#16 >> FV-3062 SIGNAL | |
| S-30-358 | 30E06 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3063<br>TO: RTU-SFL6<br>2 2/CS-#16 >> FV-3063 SIGNAL | |
| S-30-360 | 30E18 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3061<br>TO: AIT-3061<br>1 MFR >> AE-3061 SIGNAL | |
| S-30-361 | 30E18 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3061<br>TO: RTU-SFL6<br>2 2/CS-#16 >> AIT-3061 SIGNAL | |
| S-30-362 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3060<br>TO: AIT-3060<br>1 MFR >> AE-3060 SIGNAL | |
| S-30-363 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3069<br>TO: AIT-3069<br>1 MFR >> AE-3069 SIGNAL | |
| S-30-402 | 30E13 | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3071<br>TO: AIT-3071<br>2 MFR >> AE-3071 SIGNAL | |
| S-30-403 | 30E05<br>30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3071<br>TO: RTU-NFL7<br>2 2/CS-#16 >> AIT-3071 SIGNAL | |
| S-30-404 | 30E05 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3071<br>TO: FIT-3071<br>1 MFR >> FE-3071 SIGNAL | |
| S-30-405 | 30E13 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3071<br>TO: LIT-3071<br>1 MFR >> LE-3071 SIGNAL | |
| S-30-406 | 30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3071<br>TO: RTU-NFL7<br>2 2/CS-#16 >> LIT-3071 SIGNAL | |
| S-30-407 | 30E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3071<br>TO: RTU-NFL7<br>1 2/CS-#16 >> PIT-3071 SIGNAL | |
| S-30-408 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3072<br>TO: RTU-NFL7<br>2 2/CS-#16 >> FV-3072 SIGNAL | |
| S-30-409 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3073<br>TO: RTU-NFL7<br>2 2/CS-#16 >> FV-3073 SIGNAL | |
| S-30-410 | 30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3077<br>TO: RTU-NFL7<br>2 2/CS-#16 >> FV-3077 SIGNAL | |
| S-30-412 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3070<br>TO: AIT-3070<br>2 MFR >> AE-3070 SIGNAL | |
| S-30-413 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3079<br>TO: AIT-3079<br>2 MFR >> AE-3079 SIGNAL | |
| S-30-452 | 30E17 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3081<br>TO: AIT-3081<br>1 MFR >> AE-3081 SIGNAL | |
| S-30-453 | 30E05<br>30E17 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3081<br>TO: RTU-SFL8<br>2 2/CS-#16 >> AIT-3081 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER AJB
REVISION 0
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-454 | 30E05 | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3081<br>TO: FIT-3081<br>2 MFR >> FE-3081 SIGNAL | |
| S-30-455 | 30E17 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3081<br>TO: LIT-3081<br>1 MFR >> LE-3081 SIGNAL | |
| S-30-456 | 30E17 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3081<br>TO: RTU-SFL8<br>1 2/CS-#16 >> LIT-3081 SIGNAL | |
| S-30-457 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3081<br>TO: RTU-SFL8<br>2 2/CS-#16 >> PIT-3081 SIGNAL | |
| S-30-458 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3082<br>TO: RTU-SFL8<br>2 2/CS-#16 >> FV-3082 SIGNAL | |
| S-30-459 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3083<br>TO: RTU-SFL8<br>2 2/CS-#16 >> FV-3083 SIGNAL | |
| S-30-460 | 30E17 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3087<br>TO: RTU-SFL8<br>2 2/CS-#16 >> FV-3087 SIGNAL | |
| S-30-462 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3080<br>TO: AIT-3080<br>1 MFR >> AE-3080 SIGNAL | |
| S-30-463 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3089<br>TO: AIT-3089<br>1 MFR >> AE-3089 SIGNAL | |
| S-30-502 | 30E13 | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3091<br>TO: AIT-3091<br>2 MFR >> AE-3091 SIGNAL | |
| S-30-503 | 30E05<br>30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3091<br>TO: RTU-NFL9<br>2 2/CS-#16 >> AIT-3091 SIGNAL | |
| S-30-504 | 30E05 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3091<br>TO: FIT-3091<br>1 MFR >> FE-3091 SIGNAL | |
| S-30-505 | 30E13 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3091<br>TO: LIT-3091<br>1 MFR >> LE-3091 SIGNAL | |
| S-30-506 | 30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3091<br>TO: RTU-NFL9<br>2 2/CS-#16 >> LIT-3091 SIGNAL | |
| S-30-507 | 30E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3091<br>TO: RTU-NFL9<br>1 2/CS-#16 >> PIT-3091 SIGNAL | |
| S-30-508 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3092<br>TO: RTU-NFL9<br>2 2/CS-#16 >> FV-3092 SIGNAL | |
| S-30-509 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3093<br>TO: RTU-NFL9<br>2 2/CS-#16 >> FV-3093 SIGNAL | |
| S-30-510 | 30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3097<br>TO: RTU-NFL9<br>2 2/CS-#16 >> FV-3097 SIGNAL | |
| S-30-512 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3090<br>TO: AIT-3090<br>2 MFR >> AE-3090 SIGNAL | |
| S-30-513 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3099<br>TO: AIT-3099<br>2 MFR >> AE-3099 SIGNAL | |
| S-30-552 | 30E17 | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3101<br>TO: AIT-3101<br>2 MFR >> AE-3101 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-553 | 30E05<br>30E17 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3101<br>TO: RTU-SFL10<br>2 2/CS-#16 >> AIT-3101 SIGNAL | |
| S-30-554 | 30E05 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3101<br>TO: FIT-3101<br>1 MFR >> FE-3101 SIGNAL | |
| S-30-555 | 30E17 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3101<br>TO: LIT-3101<br>1 MFR >> LE-3101 SIGNAL | |
| S-30-556 | 30E17 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3101<br>TO: RTU-SFL10<br>1 2/CS-#16 >> LIT-3101 SIGNAL | |
| S-30-557 | 30E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3101<br>TO: RTU-SFL10<br>1 2/CS-#16 >> PIT-3101 SIGNAL | |
| S-30-558 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3102<br>TO: RTU-SFL10<br>2 2/CS-#16 >> FV-3102 SIGNAL | |
| S-30-559 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3103<br>TO: RTU-SFL10<br>2 2/CS-#16 >> FV-3103 SIGNAL | |
| S-30-560 | 30E17 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3107<br>TO: RTU-SFL10<br>2 2/CS-#16 >> FV-3107 SIGNAL | |
| S-30-562 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3100<br>TO: AIT-3100<br>2 MFR >> AE-3100 | |
| S-30-563 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3109<br>TO: AIT-3109<br>2 MFR >> AE-3109 | |
| S-30-602 | 30E13 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3111<br>TO: AIT-3111<br>1 MFR >> AE-3111 SIGNAL | |
| S-30-603 | 30E05<br>30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3111<br>TO: RTU-NFL11<br>2 2/CS-#16 >> AIT-3111 SIGNAL | |
| S-30-604 | 30E05 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3111<br>TO: FIT-3111<br>1 MFR >> FE-3111 SIGNAL | |
| S-30-605 | 30E13 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3111<br>TO: LIT-3111<br>1 MFR >> LE-3111 SIGNAL | |
| S-30-606 | 30E13 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3111<br>TO: RTU-NFL11<br>1 2/CS-#16 >> LIT-3111 SIGNAL | |
| S-30-607 | 30E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3111<br>TO: RTU-NFL11<br>1 2/CS-#16 >> PIT-3111 SIGNAL | |
| S-30-608 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3112<br>TO: RTU-NFL11<br>2 2/CS-#16 >> FV-3112 SIGNAL | |
| S-30-609 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3113<br>TO: RTU-NFL11<br>2 2/CS-#16 >> FV-3113 SIGNAL | |
| S-30-610 | 30E13 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3117<br>TO: RTU-NFL11<br>2 2/CS-#16 >> FV-3117 SIGNAL | |
| S-30-612 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3110<br>TO: AIT-3110<br>1 MFR >> AE-3110 SIGNAL | |
| S-30-613 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3119<br>TO: AIT-3119<br>1 MFR >> AE-3119 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-652 | 30E17 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3121<br>TO: AIT-3121<br>1 MFR >> AE-3121 SIGNAL | |
| S-30-653 | 30E05<br>30E17 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3121<br>TO: RTU-SFL12<br>2 2/CS-#16 >> AIT-3121 SIGNAL | |
| S-30-654 | 30E05 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3121<br>TO: FIT-3121<br>1 MFR >> FE-3121 SIGNAL | |
| S-30-655 | 30E17 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3121<br>TO: LIT-3121<br>1 MFR >> LE-3121 SIGNAL | |
| S-30-656 | 30E17 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3121<br>TO: RTU-SFL12<br>1 2/CS-#16 >> LIT-3121 SIGNAL | |
| S-30-657 | 30E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3121<br>TO: RTU-SFL12<br>1 2/CS-#16 >> PIT-3121 SIGNAL | |
| S-30-658 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3122<br>TO: RTU-SFL12<br>2 2/CS-#16 >> FV-3122 SIGNAL | |
| S-30-659 | 30E05 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3123<br>TO: RTU-SFL12<br>2 2/CS-#16 >> FV-3123 SIGNAL | |
| S-30-660 | 30E17 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3127<br>TO: RTU-SFL12<br>2 2/CS-#16 >> FV-3127 SIGNAL | |
| S-30-662 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3120<br>TO: AIT-3120<br>1 MFR >> AE-3120 SIGNAL | |
| S-30-663 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3129<br>TO: AIT-3129<br>1 MFR >> AE-3129 SIGNAL | |
| S-30-702 | 30E12 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3131<br>TO: AIT-3131<br>1 MFR >> AE-3131 SIGNAL | |
| S-30-703 | 30E04<br>30E12 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3131<br>TO: RTU-NFL13<br>2 2/CS-#16 >> AIT-3131 SIGNAL | |
| S-30-704 | 30E04 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3131<br>TO: FIT-3131<br>1 MFR >> FE-3131 SIGNAL | |
| S-30-705 | 30E12 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3131<br>TO: LIT-3131<br>1 MFR >> LE-3131 SIGNAL | |
| S-30-706 | 30E12 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3131<br>TO: RTU-NFL13<br>1 2/CS-#16 >> LIT-3131 SIGNAL | |
| S-30-707 | 30E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3131<br>TO: RTU-NFL13<br>1 2/CS-#16 >> PIT-3131 SIGNAL | |
| S-30-708 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3132<br>TO: RTU-NFL13<br>2 2/CS-#16 >> FV-3132 SIGNAL | |
| S-30-709 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3133<br>TO: RTU-NFL13<br>2 2/CS-#16 >> FV-3133 SIGNAL | |
| S-30-710 | 30E12 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3137<br>TO: RTU-NFL13<br>2 2/CS-#16 >> FV-3137 SIGNAL | |
| S-30-712 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3130<br>TO: AIT-3130<br>1 MFR >> AE-3130 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

ENGINEER: AJB
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-713 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3139<br>TO: AIT-3139<br>1 MFR >> AE-3139 SIGNAL | |
| S-30-752 | 30E16 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3141<br>TO: AIT-3141<br>1 MFR >> AE-3141 SIGNAL | |
| S-30-753 | 30E04<br>30E16 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3141<br>TO: RTU-SFL14<br>2 2/CS-#16 >> AIT-3141 SIGNAL | |
| S-30-754 | 30E04 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3141<br>TO: FIT-3141<br>1 MFR >> FE-3141 SIGNAL | |
| S-30-755 | 30E16 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3141<br>TO: LIT-3141<br>1 MFR >> LE-3141 SIGNAL | |
| S-30-756 | 30E16 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3141<br>TO: RTU-SFL14<br>1 2/CS-#16 >> LIT-3141 SIGNAL | |
| S-30-757 | 30E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3141<br>TO: RTU-SFL14<br>1 2/CS-#16 >> PIT-3141 SIGNAL | |
| S-30-758 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3142<br>TO: RTU-SFL14<br>2 2/CS-#16 >> FV-3142 SIGNAL | |
| S-30-759 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3143<br>TO: RTU-SFL14<br>2 2/CS-#16 >> FV-3143 SIGNAL | |
| S-30-760 | 30E16 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3147<br>TO: RTU-SFL14<br>2 2/CS-#16 >> FV-3147 SIGNAL | |
| S-30-762 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3140<br>TO: AIT-3140<br>1 MFR >> AE-3140 SIGNAL | |
| S-30-763 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3149<br>TO: AIT-3149<br>1 MFR >> AE-3149 SIGNAL | |
| S-30-802 | 30E12 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3151<br>TO: AIT-3151<br>1 MFR >> AE-3151 SIGNAL | |
| S-30-803 | 30E04<br>30E12 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3151<br>TO: RTU-NFL15<br>2 2/CS-#16 >> AIT-3151 SIGNAL | |
| S-30-804 | 30E04 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3151<br>TO: FIT-3151<br>1 MFR >> FE-3151 SIGNAL | |
| S-30-805 | 30E12 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3151<br>TO: LIT-3151<br>1 MFR >> LE-3151 SIGNAL | |
| S-30-806 | 30E12 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3151<br>TO: RTU-NFL15<br>1 2/CS-#16 >> LIT-3151 SIGNAL | |
| S-30-807 | 30E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3151<br>TO: RTU-NFL15<br>1 2/CS-#16 >> PIT-3151 SIGNAL | |
| S-30-808 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3152<br>TO: RTU-NFL15<br>2 2/CS-#16 >> FV-3152 SIGNAL | |
| S-30-809 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3153<br>TO: RTU-NFL15<br>2 2/CS-#16 >> FV-3153 SIGNAL | |
| S-30-810 | 30E12 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3157<br>TO: RTU-NFL15<br>2 2/CS-#16 >> FV-3157 SIGNAL | |

# CONDUIT SCHEDULE AREA

## FILTER AND CHEMICAL FEED UPGRADES

## FILTERS

| ENGINEER | AJB |
|---|---|
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-812 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3150<br>TO: AIT-3150<br>1 MFR >> AE-3150 SIGNAL | |
| S-30-813 | | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3159<br>TO: AIT-3159<br>1 MFR >> AE-3159 SIGNAL | |
| S-30-852 | 30E16 | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3161<br>TO: AIT-3161<br>2 MFR >> AE-3161 SIGNAL | |
| S-30-853 | 30E04<br>30E16 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: AIT-3161<br>TO: RTU-SFL16<br>2 2/CS-#16 >> AIT-3161 SIGNAL | |
| S-30-854 | 30E04 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-3161<br>TO: FIT-3161<br>1 MFR >> FE-3161 SIGNAL | |
| S-30-855 | 30E16 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3161<br>TO: LIT-3161<br>1 MFR >> LE-3161 SIGNAL | |
| S-30-856 | 30E16 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3161<br>TO: RTU-SFL16<br>1 2/CS-#16 >> LIT-3161 SIGNAL | |
| S-30-857 | 30E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PIT-3161<br>TO: RTU-SFL16<br>1 2/CS-#16 >> PIT-3161 SIGNAL | |
| S-30-858 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3162<br>TO: RTU-SFL16<br>2 2/CS-#16 >> FV-3162 SIGNAL | |
| S-30-859 | 30E04 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3163<br>TO: RTU-SFL16<br>2 2/CS-#16 >> FV-3163 SIGNAL | |
| S-30-860 | 30E16 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-3167<br>TO: RTU-SFL16<br>2 2/CS-#16 >> FV-3167 SIGNAL | |
| S-30-862 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3160<br>TO: AIT-3160<br>2 MFR >> AE-3160 SIGNAL | |
| S-30-863 | | 0.75" | 2 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AE-3169<br>TO: AIT-3169<br>2 MFR >> AE-3169 SIGNAL | |
| S-30-903 | 30E07 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-4051<br>TO: RTU-ELEC2C<br>2 2/CS-#16 >> FV-4051 SIGNAL | |
| S-30-904 | 30E07 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-4061<br>TO: RTU-ELEC2C<br>2 2/CS-#16 >> FV-4061 SIGNAL | |
| S-30-905 | 30E04 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-4135<br>TO: FIT-4135<br>1 MFR >> FE-4135 SIGNAL | |
| S-30-906 | 30E07 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-4136<br>TO: FIT-4136<br>1 MFR >> FE-4136 SIGNAL | |
| S-30-907 | 30E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FV-4411<br>TO: RTU-FBW<br>2 2/CS-#16 >> FV-4411 SIGNAL | |
| S-30-908 | 30E02 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: FE-4411<br>TO: FIT-4411<br>1 MFR >> FE-4411 SIGNAL | |
| S-30-914 | 30E06 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FIT-4136<br>TO: RTU-FBW<br>1 2/CS-#16 >> FIT-4136 SIGNAL | |
| S-30-930 | 30E13 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3001<br>TO: LIT-3001<br>1 MFR >> LE-3001 SIGNAL | |

# CONDUIT SCHEDULE AREA

**FILTER AND CHEMICAL FEED UPGRADES**

**FILTERS**

| | |
|---|---|
| ENGINEER | AJB |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-30-931 | 30E13 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3001<br>TO: RTU-FBW<br>1 2/CS-#16 >> LIT-3001 SIGNAL | |
| S-30-932 | 30E17 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-3002<br>TO: LIT-3002<br>1 MFR >> LE-3002 SIGNAL | |
| S-30-933 | 30E17 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-3002<br>TO: RTU-FBW<br>1 2/CS-#16 >> LIT-3002 SIGNAL | |

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990C

CONDUIT SCHEDULE
AREA 41

# PART 1 GENERAL

## 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. MFR: Manufacturer or vendor furnished cable.
   5. PULL: Pull Rope.
   6. VFD: Shielded VFD cable with integral ground.

# PART 2 PRODUCTS

Not Used.

# PART 3 EXECUTION

## 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 41

## FILTER AND CHEMICAL FEED UPGRADES

## BACKWASH TANK AND VAULT

| | |
|---|---|
| ENGINEER | SKB |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-41-115 | 02E01<br>41E01 | 2" | 1 | PULL | ROPE | | | | FR: STUB-UP AT BACKWASH TANK<br>TO: PB-15<br>1 PULL >> SPARE | |
| C-41-211 | 41E01 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-4112<br>TO: J-BOX<br>10 #14 >> FV-4112 CONTROL | C-41-226 |
| C-41-221 | 41E01 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-4122<br>TO: J-BOX<br>10 #14 >> FV-4122 CONTROL | C-41-226 |
| C-41-225 | 41E01 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSHH-4123<br>TO: J-BOX<br>2 #14 >> LSHH-4123 CONTROL | C-41-226 |
| C-41-226 | 02E01<br>41E01 | 2" | 22 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: J-BOX<br>TO: PB-15<br>10 #14 >> FV-4112 CONTROL<br>10 #14 >> FV-4122 CONTROL<br>2 #14 >> LSHH-4123 CONTROL | C-41-227<br><br>C-41-211<br>C-41-221<br>C-41-225 |
| C-41-227 | 02E01 | 2" | 22 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PB-15<br>TO: PB-14<br>10 #14 >> FV-4112 CONTROL<br>10 #14 >> FV-4122 CONTROL<br>2 #14 >> LSHH-4123 CONTROL | C-41-228<br><br>C-41-226<br>C-41-226<br>C-41-226 |
| C-41-228 | 02E01 | 2" | 22 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PB-14<br>TO: RTU-CS<br>10 #14 >> FV-4112 CONTROL<br>10 #14 >> FV-4122 CONTROL<br>2 #14 >> LSHH-4123 CONTROL | <br><br>C-41-227<br>C-41-227<br>C-41-227 |
| C-41-412 | 30E09 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VFD-4101<br>TO: RTU-ELEC1<br>8 #14 >> VFD-4101 CONTROL (120VAC)<br>4 #14 >> SPARE | |
| C-41-415 | 30E09 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VFD-4101<br>TO: RTU-ELEC1<br>5 #14 >> VFD-4101 CONTROL (24VDC)<br>2 #14 >> SPARE | |
| C-41-422 | 30E09 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VFD-4102<br>TO: RTU-ELEC1<br>8 #14 >> VFD-4102 CONTROL (120VAC)<br>4 #14 >> SPARE | |
| C-41-425 | 30E09 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VFD-4102<br>TO: RTU-ELEC1<br>5 #14 >> VFD-4102 CONTROL (24VDC)<br>2 #14 >> SPARE | |
| L-41-224 | 41E01 | 1" | 2 | #4 | XHHW-2 | 1 | #4 | XHHW-2 | FR: PMP-4125<br>TO: J-BOX<br>2 #4 >> PMP-4125 POWER | L-41-225 |
| L-41-225 | 02E01<br>41E01 | 2" | 2<br>2<br>4 | #4<br>#6<br>#12 | XHHW-2<br>XHHW-2<br>XHHW-2 | 1 | #4 | XHHW-2 | FR: J-BOX<br>TO: PB-15<br>2 #4 >> PMP-4125 POWER<br>2 #12 >> FAN-4151 POWER<br>2 #12 >> BACKWASH VALVE VAULT LIGHTING<br>2 #6 >> BACKWASH VALVE VAULT RECEPTACL | L-41-226<br><br>L-41-224 |
| L-41-226 | 02E01 | 2" | 2<br>2<br>4 | #4<br>#6<br>#12 | XHHW-2<br>XHHW-2<br>XHHW-2 | 1 | #4 | XHHW-2 | FR: PB-15<br>TO: PB-14<br>2 #4 >> PMP-4125 POWER<br>2 #12 >> FAN-4151 POWER<br>2 #12 >> BACKWASH VALVE VAULT LIGHTING<br>2 #6 >> BACKWASH VALVE VAULT RECEPTACL | L-41-227<br><br>L-41-225<br>L-41-225<br>L-41-225<br>L-41-225 |
| L-41-227 | 02E01 | 2" | 2<br>2<br>4 | #4<br>#6<br>#12 | XHHW-2<br>XHHW-2<br>XHHW-2 | 1 | #4 | XHHW-2 | FR: PB-14<br>TO: PNL-CS<br>2 #4 >> PMP-4125 POWER<br>2 #12 >> FAN-4151 POWER<br>2 #12 >> BACKWASH VALVE VAULT LIGHTING<br>2 #6 >> BACKWASH VALVE VAULT RECEPTACL | <br><br>L-41-226<br>L-41-226<br>L-41-226<br>L-41-226 |
| P-41-211 | 41E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FV-4112<br>TO: DISC-4112<br>3 #12 >> FV-4112 POWER | P-41-212 |

# CONDUIT SCHEDULE AREA 41

**FILTER AND CHEMICAL FEED UPGRADES**

**BACKWASH TANK AND VAULT**

| | |
|---|---|
| ENGINEER | SKB |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-41-212 | 41E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4112<br>TO: CONDUIT TEE<br>3 #12 >> FV-4112 POWER | P-41-223<br><br>P-41-211 |
| P-41-221 | 41E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FV-4122<br>TO: DISC-4122<br>3 #12 >> FV-4122 POWER | P-41-222 |
| P-41-222 | 41E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-4112<br>TO: CONDUIT TEE<br>3 #12 >> FV-4122 POWER | P-41-223<br><br>P-41-221 |
| P-41-223 | 02E01<br>41E01 | 2" | 6 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: CONDUIT TEE<br>TO: PB-15<br>3 #12 >> FV-4112 POWER<br>3 #12 >> FV-4122 POWER | P-41-224<br><br>P-41-212<br>P-41-222 |
| P-41-224 | 02E01 | 2" | 6 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PB-15<br>TO: PB-14<br>3 #12 >> FV-4112 POWER<br>3 #12 >> FV-4122 POWER | P-41-225<br><br>P-41-223<br>P-41-223 |
| P-41-225 | 02E01 | 2" | 6 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PB-14<br>TO: PP-CS<br>3 #12 >> FV-4112 POWER<br>3 #12 >> FV-4122 POWER | <br><br>P-41-224<br>P-41-224 |
| P-41-411 | 30E04 | 3.5" | 1<br>2<br>2 | 3/C-#4/0:VFD<br>#12<br>#14 | VFD<br>XHHW-2<br>XHHW-2 | | | INTEGRAL | FR: PMP-4101<br>TO: VFD-4101<br>1 3/C-#4/0:VFD >> PMP-4101 POWER<br>2 #12 >> MWH-4101 POWER<br>2 #14 >> TSH-4101 CONTROL | |
| P-41-412 | 30E09 | 2.5" | 3 | 350 | XHHW-2 | 1 | #4 | XHHW-2 | FR: VFD-4101<br>TO: MCC-A<br>3 350 >> VFD-4101 POWER | |
| P-41-421 | 30E04 | 3.5" | 1<br>2<br>2 | 3/C-#4/0:VFD<br>#12<br>#14 | VFD<br>XHHW-2<br>XHHW-2 | | | INTEGRAL | FR: PMP-4102<br>TO: VFD-4102<br>1 3/C-#4/0:VFD >> PMP-4102 POWER<br>2 #12 >> MWH-4102 POWER<br>2 #14 >> TSH-4102 CONTROL | |
| P-41-422 | 30E09 | 2.5" | 3 | 350 | XHHW-2 | 1 | #4 | XHHW-2 | FR: VFD-4102<br>TO: MCC-A1<br>3 350 >> VFD-4102 POWER | |
| S-41-121 | 41E01 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-4122<br>TO: LIT-4122<br>1 MFR >> LE-4122 SIGNAL | |
| S-41-122 | 02E01<br>41E01 | 2" | 2<br>1 | #10<br>2/CS-#16 | XHHW-2 | 1 | #10 | XHHW-2 | FR: LIT-4122<br>TO: PB-14<br>1 2/CS-#16 >> LIT-4122 SIGNAL<br>2 #10 >> LIT-4122 POWER (24VDC) | S-41-123 |
| S-41-123 | 02E01 | 2" | 2<br>1 | #10<br>2/CS-#16 | XHHW-2 | 1 | #10 | XHHW-2 | FR: PB-14<br>TO: RTU-CS<br>1 2/CS-#16 >> LIT-4122 SIGNAL<br>2 #10 >> LIT-4122 POWER (24VDC) | <br><br>S-41-122<br>S-41-122 |
| S-41-412 | 30E09 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VFD-4101<br>TO: RTU-ELEC1<br>2 2/CS-#16 >> VFD-4101 SIGNAL | |
| S-41-422 | 30E09 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VFD-4102<br>TO: RTU-ELEC1<br>2 2/CS-#16 >> VFD-4102 SIGNAL | |
| X-41-311 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: BACKWASH TANK VAULT<br>TO: PB-15<br>1 PULL >> SPARE | X-41-312 |
| X-41-312 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-15<br>TO: PB-14<br>1 PULL >> SPARE | X-41-313<br><br>X-41-311 |
| X-41-313 | 02E01 | 2" | 1 | PULL | ROPE | | | | FR: PB-14<br>TO: STUB-UP IN CAUSTIC SODA ELEC ROOM<br>1 PULL >> SPARE | <br><br>X-41-312 |

# CONDUIT SCHEDULE AREA 41

**FILTER AND CHEMICAL FEED UPGRADES**

**BACKWASH TANK AND VAULT**

| ENGINEER | SKB |
|---|---|
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| X-41-351 | 02E01<br>41E01 | 2" | 1 | PULL | ROPE | | | | FR: STUB-UP AT BACKWASH TANK<br>TO: PB-15<br>1 PULL >> SPARE | |
| | | | | | | | | | | |
| X-41-361 | 02E01<br>41E01 | 2" | 1 | PULL | ROPE | | | | FR: STUB-UP AT BACKWASH TANK<br>TO: PB-14<br>1 PULL >> SPARE | |
| | | | | | | | | | | |

END OF CONDUIT SCHEDULE

END OF SECTION

**SECTION 16990D**

**CONDUIT SCHEDULE**
**AREA 55**

## PART 1 GENERAL

### 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. PULL: Pull Rope.

## PART 2 PRODUCTS

Not Used.

## PART 3 EXECUTION

### 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 55

**FILTER AND CHEMICAL FEED UPGRADES**

**CULINARY PUMP STATION**

| ENGINEER | SKB |
|---|---|
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-55-201 | 55E01 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ATS-5501<br>TO: RTU-CPS<br>6 #14 >> ATS-5501 CONTROL | |
| C-55-202 | 02E02<br>55E01 | 2" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: GEN-5501<br>TO: RTU-CPS<br>10 #14 >> GEN-5501 CONTROL | |
| C-55-211 | 02E02<br>55E01 | 2" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ATS-5501<br>TO: GEN-5501<br>12 #14 >> ATS-5501 CONTROL | |
| L-55-202 | 02E02<br>55E01 | 2" | 4 | #8 | XHHW-2 | 1 | #10 | XHHW-2 | FR: GEN-5501<br>TO: PANEL CPS<br>4 #8 >> GEN-5501 POWER | |
| L-55-252 | 02E02<br>55E01 | 2" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: SWBD-CPS<br>TO: PNL-CPS<br>2 #10 >> SWBD-CPS POWER | |
| P-55-101 | 02E02 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: GEN-5501<br>TO: SWBD-CPS<br>3 350 >> GEN-5501 POWER | |
| P-55-102 | 02E02 | 4" | 3 | 350 | XHHW-2 | 1 | #1 | XHHW-2 | FR: GEN-5501<br>TO: SWBD-CPS<br>3 350 >> GEN-5501 POWER | |
| P-55-111 | 02E02<br>55E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #3 | XHHW-2 | FR: SWBD-CPS<br>TO: ATS-5501<br>3 #4/0 >> SWBD-CPS POWER | |
| P-55-112 | 02E02<br>55E01 | 4" | 3 | #4/0 | XHHW-2 | 1 | #3 | XHHW-2 | FR: SWBD-CPS<br>TO: ATS-5501<br>3 #4/0 >> SWBD-CPS POWER | |
| P-55-121 | 55E01 | 2" | 3 | #2/0 | XHHW-2 | 1 | #4 | XHHW-2 | FR: ATS-5501<br>TO: XFMR-CPS<br>3 #2/0 >> ATS-5501 POWER | |
| P-55-122 | 55E01 | 2" | 3 | #2/0 | XHHW-2 | 1 | #4 | XHHW-2 | FR: ATS-5501<br>TO: XFMR-CPS<br>3 #2/0 >> ATS-5501 POWER | |
| P-55-301 | 55E01 | 2" | 3 | #2/0 | XHHW-2 | 1 | #1 | XHHW-2 | FR: MCC-CPS<br>TO: ATS-5501<br>3 #2/0 >> MCC-CPS POWER | |
| P-55-302 | 55E01 | 2" | 3 | #2/0 | XHHW-2 | 1 | #1 | XHHW-2 | FR: MCC-CPS<br>TO: ATS-5501<br>3 #2/0 >> MCC-CPS POWER | |
| X-55-401 | 02E02<br>55E01 | 2" | 1 | PULL | ROPE | | | | FR: GEN-5501<br>TO: STUB-UP AT CPS<br>1 PULL >> SPARE | |
| X-55-402 | 02E02<br>55E01 | 2" | 1 | PULL | ROPE | | | | FR: GEN-5501<br>TO: STUB-UP AT CPS<br>1 PULL >> SPARE | |
| X-55-421 | 02E02 | 4" | 1 | PULL | ROPE | | | | FR: GEN-5501<br>TO: SWBD-CPS<br>1 PULL >> SPARE | |
| X-55-422 | 02E02 | 2" | 1 | PULL | ROPE | | | | FR: GEN-5501<br>TO: SWBD-CPS<br>1 PULL >> SPARE | |
| X-55-423 | 02E02 | 2" | 1 | PULL | ROPE | | | | FR: GEN-5501<br>TO: SWBD-CPS<br>1 PULL >> SPARE | |
| X-55-425 | 02E02<br>55E01 | 4" | 1 | PULL | ROPE | | | | FR: SWBD-CPS<br>TO: STUB-UP AT CPS<br>1 PULL >> SPARE | |

END OF CONDUIT SCHEDULE

END OF SECTION

## SECTION 16990E

## CONDUIT SCHEDULE
## AREA 62 & 66

## PART 1 GENERAL

### 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. PULL: Pull Rope.

## PART 2 PRODUCTS

Not Used.

## PART 3 EXECUTION

### 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 62 & 66

**FILTER AND CHEMICAL FEED UPGRADES**

**PRIMARY COAGULANT BUILDING & FLUORIDE BUILDING**

ENGINEER: SKB
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-62-201 | 71E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6201<br>TO: RTU-PEA<br>2 #14 >> RTU-PEA CONTROL | |
| C-62-211 | 62E01 | 0.75" | 3 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6201<br>TO: J-BOX<br>3 #14 >> PISH-6201 CONTROL | C-62-225 |
| C-62-221 | 62E01 | 0.75" | 3 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6202<br>TO: J-BOX<br>3 #14 >> PISH-6202 CONTROL | C-62-225 |
| C-62-225 | 01E03<br>62E01 | 1" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: J-BOX<br>TO: MCC-CDS<br>3 #14 >> PISH-6201 CONTROL<br>3 #14 >> PISH-6202 CONTROL | <br><br>C-62-211<br>C-62-221 |
| C-62-251 | 77E01 | 1.5" | 48 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MCC-CDS<br>TO: RTU-CDS<br>24 #14 >> FVNR-6201 CONTROL<br>24 #14 >> FVNR-6202 CONTROL | |
| C-62-311 | 62E01 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6201<br>TO: J-BOX<br>6 #14 >> LCP-6201 CONTROL | C-62-325 |
| C-62-321 | 62E01 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6202<br>TO: J-BOX<br>6 #14 >> LCP-6202 CONTROL | C-62-325 |
| C-62-325 | 01E03<br>62E01 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: J-BOX<br>TO: RTU-CDS<br>6 #14 >> LCP-6201 CONTROL<br>6 #14 >> LCP-6202 CONTROL | <br><br>C-62-311<br>C-62-321 |
| P-62-211 | 01E03<br>62E01 | 1" | 5<br>2 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6201<br>TO: MCC-CDS<br>3 #12 >> PMP-6201 POWER<br>2 #12 >> MWH-6201 POWER<br>2 #14 >> TSH-6201 CONTROL | |
| P-62-221 | 01E03<br>62E01 | 1" | 5<br>2 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6202<br>TO: MCC-CDS<br>3 #12 >> PMP-6202 POWER<br>2 #12 >> MWH-6202 POWER<br>2 #14 >> TSH-6202 CONTROL | |
| X-62-411 | 01E03 | 1" | 1 | PULL | ROPE | | | | FR: PRIMARY COAGULANT BUILDING<br>TO: RTU-CDS<br>1 PULL >> SPARE | |
| L-66-111 | 66E01 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FIT-6691<br>TO: RTU-FL<br>2 #12 >> FIT-6691 POWER | |
| S-66-111 | 66E01 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FIT-6691<br>TO: RTU-FL<br>1 2/CS-#16 >> FIT-6691 SIGNAL | |

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990F

CONDUIT SCHEDULE
AREA 63

# PART 1 GENERAL

## 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */FO: Fiber optic (* indicates strand count).
   4. CAT6: Category 6 Ethernet cable.
   5. PULL: Pull Rope.

# PART 2 PRODUCTS

Not Used.

# PART 3 EXECUTION

## 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

ENGINEER: MJG
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-63-001 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6301<br>TO: VCP-6301<br>10 #14 >> FV-6301 CONTROL | |
| C-63-002 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6302<br>TO: VCP-6301<br>10 #14 >> FV-6302 CONTROL | |
| C-63-003 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6303<br>TO: VCP-6303<br>10 #14 >> FV-6303 CONTROL | |
| C-63-004 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6304<br>TO: VCP-6303<br>10 #14 >> FV-6304 CONTROL | |
| C-63-005 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6305<br>TO: VCP-6305<br>10 #14 >> FV-6305 CONTROL | |
| C-63-006 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6306<br>TO: VCP-6305<br>10 #14 >> FV-6306 CONTROL | |
| C-63-007 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6307<br>TO: VCP-6307<br>10 #14 >> FV-6307 CONTROL | |
| C-63-008 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6308<br>TO: VCP-6307<br>10 #14 >> FV-6308 CONTROL | |
| C-63-009 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6309<br>TO: VCP-6309<br>10 #14 >> FV-6309 CONTROL | |
| C-63-010 | 63E03 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6310<br>TO: VCP-6309<br>10 #14 >> FV-6310 CONTROL | |
| C-63-011 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6311<br>TO: VCP-6311<br>10 #14 >> FV-6311 CONTROL | |
| C-63-012 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6312<br>TO: VCP-6311<br>10 #14 >> FV-6312 CONTROL | |
| C-63-013 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6313<br>TO: VCP-6314<br>10 #14 >> FV-6313 CONTROL | |
| C-63-014 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6314<br>TO: VCP-6314<br>10 #14 >> FV-6314 CONTROL | |
| C-63-015 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6315<br>TO: VCP-6316<br>10 #14 >> FV-6315 CONTROL | |
| C-63-016 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6316<br>TO: VCP-6316<br>10 #14 >> FV-6316 CONTROL | |
| C-63-017 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6317<br>TO: VCP-6318<br>10 #14 >> FV-6317 CONTROL | |
| C-63-018 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6318<br>TO: VCP-6318<br>10 #14 >> FV-6318 CONTROL | |
| C-63-019 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6319<br>TO: VCP-6320<br>10 #14 >> FV-6319 CONTROL | |
| C-63-020 | 63E04 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6320<br>TO: VCP-6320<br>10 #14 >> FV-6320 CONTROL | |
| C-63-022 | 63E03 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6301<br>TO: LCP-6361<br>8 #14 >> VCP-6301 CONTROL | |

# CONDUIT SCHEDULE AREA 63

**JVWTP FILTER AND CHEMICAL FEED UPGRADES**

**CHLORINE BUILDING**

| | |
|---|---|
| ENGINEER | MJG |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-63-024 | 63E03 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6303<br>TO: LCP-6361<br>8 #14 >> VCP-6303 CONTROL | |
| C-63-026 | 63E03 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6305<br>TO: LCP-6361<br>8 #14 >> VCP-6305 CONTROL | |
| C-63-028 | 63E03 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6307<br>TO: LCP-6361<br>8 #14 >> VCP-6307 CONTROL | |
| C-63-030 | 63E03 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6309<br>TO: LCP-6361<br>8 #14 >> VCP-6309 CONTROL | |
| C-63-032 | 63E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6311<br>TO: LCP-6361<br>8 #14 >> VCP-6311 CONTROL | |
| C-63-034 | 63E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6314<br>TO: LCP-6361<br>8 #14 >> VCP-6314 CONTROL | |
| C-63-036 | 63E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6316<br>TO: LCP-6361<br>8 #14 >> VCP-6316 CONTROL | |
| C-63-038 | 63E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6318<br>TO: LCP-6361<br>8 #14 >> VCP-6318 CONTROL | |
| C-63-040 | 63E04 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6320<br>TO: LCP-6361<br>8 #14 >> VCP-6320 CONTROL | |
| C-63-041 | 63E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6301<br>TO: RTU-CL<br>2 #14 >> FSH-6301 CONTROL | |
| C-63-042 | 63E07 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6302<br>TO: RTU-CL<br>2 #14 >> FSH-6302 CONTROL | |
| C-63-043 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6333<br>TO: RTU-CL<br>2 #14 >> FSH-6333 CONTROL | |
| C-63-044 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6331<br>TO: RTU-CL<br>2 #14 >> FSH-6331 CONTROL | |
| C-63-051 | 63E02 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6331<br>TO: RTU-CL<br>12 #14 >> VCP-6331 CONTROL | |
| C-63-052 | 63E02 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6332<br>TO: RTU-CL<br>12 #14 >> VCP-6332 CONTROL | |
| C-63-053 | 63E02 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6333<br>TO: RTU-CL<br>12 #14 >> VCP-6333 CONTROL | |
| C-63-054 | 63E02 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6334<br>TO: RTU-CL<br>12 #14 >> VCP-6334 CONTROL | |
| C-63-055 | 63E02 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6335<br>TO: RTU-CL<br>12 #14 >> VCP-6335 CONTROL | |
| C-63-056 | 63E02 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6336<br>TO: RTU-CL<br>12 #14 >> VCP-6336 CONTROL | |
| C-63-060 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISL-6350<br>TO: RTU-CL<br>2 #14 >> PISL-6350 CONTROL | |
| C-63-062 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISL-6352<br>TO: RTU-CL<br>2 #14 >> PISL-6352 CONTROL | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

| ENGINEER | MJG |
|---|---|
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-63-063 | 63E09 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSHH-6319<br>TO: PNL-CL<br>2 #14 >> LSHH-6319 CONTROL | |
| C-63-071 | 63E08 | 0.75" | 2<br>2 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: BLR-6391<br>TO: MCC-CL<br>2 #12 >> MWH-6391 CONTROL<br>2 #14 >> TSH-6391 CONTROL | |
| C-63-072 | 63E08 | 0.75" | 2<br>2 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: BLR-6392<br>TO: MCC-CL<br>2 #12 >> MWH-6392 CONTROL<br>2 #14 >> TSH-6392 CONTROL | |
| C-63-073 | 63E08 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-6391<br>TO: RTU-CL<br>2 #14 >> FSL-6391 CONTROL POWER<br>2 #14 >> FSL-6391 CONTROL | |
| C-63-074 | 63E08 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-6392<br>TO: RTU-CL<br>2 #14 >> FSL-6392 CONTROL POWER<br>2 #14 >> FSL-6392 CONTROL | |
| C-63-075 | 63E08 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6391<br>TO: MCC-CL<br>6 #14 >> LCP-6391 CONTROL | |
| C-63-076 | 63E08 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6392<br>TO: MCC-CL<br>6 #14 >> LCP-6392 CONTROL | |
| C-63-081 | 63E12 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: HP-6351<br>TO: AHU-6351<br>6 #14 >> HP-6351 CONTROL | |
| C-63-082 | 63E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: TSHL-6351<br>TO: AHU-6351<br>6 #14 >> TSHL-6351 CONTROL | |
| C-63-083 | 63E12 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: HP-6352<br>TO: AHU-6352<br>6 #14 >> HP-6352 CONTROL | |
| C-63-084 | 63E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: TSHL-6352<br>TO: AHU-6352<br>6 #14 >> TSHL-6352 CONTROL | |
| C-63-085 | 63E05 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PPU-6353<br>TO: RTU-CL<br>12 #14 >> PPU-6353 CONTROL | |
| C-63-086 | 63E07 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: TSHL-6354<br>TO: MAU-6354<br>6 #14 >> TSHL-6354 CONTROL | |
| C-63-087 | 63E12 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XS-6354<br>TO: MAU-6354<br>4 #14 >> XS-6354 CONTROL | |
| C-63-088 | 63E12 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MAU-6354<br>TO: RTU-CL<br>14 #14 >> MAU-6354 CONTROL | |
| C-63-089 | 63E10 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LVR-6355<br>TO: RTU-CL<br>7 #14 >> LVR-6355 (24VDC) CONTROL | |
| C-63-090 | 63E12 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XS-6355<br>TO: MCC-CL<br>6 #14 >> XS-6355 CONTROL | |
| C-63-092 | 63E09 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LVR-6356<br>TO: RTU-CL<br>7 #14 >> LVR-6356 (24VDC) CONTROL | |
| C-63-093 | 63E12 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XS-6356<br>TO: MCC-CL<br>6 #14 >> XS-6356 CONTROL | |
| C-63-095 | 63E02 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FVNR-6368<br>TO: RTU-CL<br>8 #14 >> LCP-6368 CONTROL | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

| | |
|---|---|
| ENGINEER | MJG |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-63-096 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: TSH-6368<br>TO: FVNR-6368<br>2 #14 >> TSH-6368 CONTROL | |
| C-63-097 | 63E02 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FVNR-6357<br>TO: RTU-CL<br>8 #14 >> LCP-6357 CONTROL | |
| C-63-098 | 63E11 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LVR-6357<br>TO: RTU-CL<br>7 #14 >> LVR-6357 (24VDC) CONTROL | |
| C-63-100 | 63E05 | 1.5" | 28 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MCC-CL<br>TO: RTU-CL<br>2 #14 >> CL-6301 SPD FAIL STATUS<br>7 #14 >> EF-6355 STARTER CONTROLS<br>7 #14 >> EF-6356 STARTER CONTROLS<br>6 #14 >> RVSS-6391 CONTROLS<br>6 #14 >> RVSS-6392 CONTROLS | |
| C-63-101 | 63E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ZSC-6381<br>TO: LCP-6361<br>2 #14 >> ZSC-6381 CONTROL | |
| C-63-102 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ZSC-6382<br>TO: LCP-6361<br>2 #14 >> ZSC-6382 CONTROL | |
| C-63-103 | 63E07 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ZSC-6383<br>TO: LCP-6361<br>2 #14 >> ZSC-6383 CONTROL | |
| C-63-104 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ZSC-6384<br>TO: LCP-6361<br>2 #14 >> ZSC-6384 CONTROL | |
| C-63-105 | 63E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ZSC-6385<br>TO: LCP-6361<br>2 #14 >> ZSC-6385 CONTROL | |
| C-63-106 | 63E09 | 1" | 15 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6381<br>TO: LCP-6361<br>15 #14 >> LCP-6381 CONTROL | |
| C-63-107 | 63E10 | 1" | 15 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6382<br>TO: LCP-6361<br>15 #14 >> LCP-6382 CONTROL | |
| C-63-108 | 63E07 | 1" | 15 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6383<br>TO: LCP-6361<br>15 #14 >> LCP-6383 CONTROL | |
| C-63-109 | 63E02 | 1" | 15 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6384<br>TO: LCP-6361<br>15 #14 >> LCP-6384 CONTROL | |
| C-63-110 | 63E02 | 1" | 15 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6385<br>TO: LCP-6361<br>15 #14 >> LCP-6385 CONTROL | |
| C-63-111 | 63E05 | 1.5" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6361<br>TO: MCC-CL<br>2 #14 >> RVSS-6391 FAIL (24VDC) STATUS<br>2 #14 >> RVSS-6392 FAIL (24VDC) STATUS | |
| C-63-112 | 63E05 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6361<br>TO: MCC-CL<br>2 #14 >> EF-6355 START CONTROL<br>2 #14 >> EF-6356 START CONTROL<br>2 #14 >> EF-6357 START CONTROL<br>2 #14 >> SF-6358 START CONTROL<br>2 #14 >> RVSS-6391 START CONTROL<br>2 #14 >> RVSS-6392 START CONTROL | |
| C-63-113 | 63E05 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6361<br>TO: PANEL-MOUNTED BEACONS<br>6 #14 >> BEACON CONTROLS | |
| C-63-114 | 63E11 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XH3-6361 & XH5-6361<br>TO: LCP-6361<br>4 #14 >> CL2 STORAGE HORN & STROBE CONTF | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

ENGINEER: MJG
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-63-115 | 63E11 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XH2-6361 & XH4-6361<br>TO: LCP-6361<br>4 #14 >> CL2 FEED HORN & STROBE CONTROLS | |
| C-63-116 | 63E09 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ZSC-6386<br>TO: LCP-6361<br>2 #14 >> ZSC-6386 CONTROL | |
| C-63-117 | 63E10 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: ZSC-6387<br>TO: LCP-6361<br>2 #14 >> ZSC-6387 CONTROL | |
| C-63-611 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 63-D102-03 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-63-621 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 63-D102-02 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-63-631 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 63-D105-01 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-63-641 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 63-D104-01 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-63-651 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 63-D103-01 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-63-661 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 63-D101-01 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-63-671 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 63-D101-02 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| L-63-021 | 63E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6301<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6301 POWER | |
| L-63-023 | 63E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6303<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6303 POWER | |
| L-63-025 | 63E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6305<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6305 POWER | |
| L-63-027 | 63E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6307<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6307 POWER | |
| L-63-029 | 63E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6309<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6309 POWER | |
| L-63-031 | 63E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6311<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6311 POWER | |
| L-63-033 | 63E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6314<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6314 POWER | |
| L-63-035 | 63E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6316<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6316 POWER | |
| L-63-037 | 63E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6318<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6318 POWER | |
| L-63-039 | 63E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6320<br>TO: PNL-UPS-CL<br>2 #12 >> VCP-6320 POWER | |
| L-63-041 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: HTU-6331<br>TO: PNL-CL<br>2 #12 >> HTU-6331 POWER | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

ENGINEER MJG
REVISION
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| L-63-042 | 63E02 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6332<br>TO: PNL-CL<br>2 #10 >> HTU-6332 POWER | |
| L-63-051 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6331<br>TO: RTU-CL<br>2 #12 >> VCP-6331 POWER | |
| L-63-052 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6332<br>TO: RTU-CL<br>2 #12 >> VCP-6332 POWER | |
| L-63-053 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6333<br>TO: RTU-CL<br>2 #12 >> VCP-6333 POWER | |
| L-63-054 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6334<br>TO: RTU-CL<br>2 #12 >> VCP-6334 POWER | |
| L-63-055 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6335<br>TO: RTU-CL<br>2 #12 >> VCP-6335 POWER | |
| L-63-056 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6336<br>TO: RTU-CL<br>2 #12 >> VCP-6336 POWER | |
| L-63-060 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISL-6350<br>TO: RTU-CL<br>2 #12 >> PISL-6350 POWER | |
| L-63-062 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISL-6352<br>TO: RTU-CL<br>2 #12 >> PISL-6352 POWER | |
| L-63-063 | 63E09 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6319<br>TO: PNL-CL<br>2 #12 >> PMP-6319 POWER | |
| L-63-071 | 63E05 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SECURITY PANEL<br>TO: PNL-CL<br>2 #12 >> SECURITY PANEL (UTILITY) POWER | |
| L-63-072 | 63E05 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SECURITY PANEL<br>TO: PNL-UPS-CL<br>2 #12 >> SECURITY PANEL (UPS) POWER | |
| L-63-085 | 63E12 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HP-6351<br>TO: CONDUIT TEE<br>2 #10 >> HP-6351 POWER | L-63-087 |
| L-63-086 | 63E12 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HP-6352<br>TO: CONDUIT TEE<br>2 #10 >> HP-6352 POWER | L-63-087 |
| L-63-087 | 63E12 | 0.75" | 4 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: CONDUIT TEE<br>TO: PNL-CL<br>2 #10 >> HP-6351 POWER<br>2 #10 >> HP-6352 POWER | <br><br>L-63-085<br>L-63-086 |
| L-63-088 | 63E10 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LVR-6355<br>TO: PNL-CL<br>2 #12 >> LVR-6355 POWER | |
| L-63-089 | 63E09 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LVR-6356<br>TO: PNL-CL<br>2 #12 >> LVR-6356 POWER | |
| L-63-090 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SF-6368<br>TO: FVNR-6368<br>2 #12 >> SF-6368 POWER | |
| L-63-091 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FVNR-6368<br>TO: PNL-CL<br>2 #12 >> FVNR-6368 POWER | |
| L-63-093 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: EF-6357<br>TO: FVNR-6357<br>2 #12 >> EF-6357 POWER | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

ENGINEER: MJG
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| L-63-094 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FVNR-6357<br>TO: PNL-CL<br>2 #12 >> DISC-6357 POWER | |
| L-63-096 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LVR-6357<br>TO: PNL-CL<br>2 #12 >> LVR-6357 POWER | |
| L-63-097 | 63E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: RTU-CL<br>TO: PNL-CL<br>2 #10 >> RTU-CL (UTILITY) POWER | |
| L-63-098 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LOI-CL<br>TO: RTU-CL<br>2 #12 >> LOI-CL (UPS) POWER | |
| L-63-099 | 63E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: LCP-6361<br>TO: PNL-UPS-CL<br>2 #10 >> LCP-6361 (UPS) POWER | |
| L-63-100 | 63E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: RTU-CL<br>TO: PNL-UPS-CL<br>2 #10 >> RTU-CL (UPS) POWER | |
| L-63-101 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6358<br>TO: PNL-CL<br>2 #12 >> GUH-6358 POWER | |
| L-63-102 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6359<br>TO: PNL-CL<br>2 #12 >> GUH-6359 POWER | |
| L-63-103 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6360<br>TO: PNL-CL<br>2 #12 >> GUH-6360 POWER | |
| L-63-104 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6361<br>TO: PNL-CL<br>2 #12 >> GUH-6361 POWER | |
| L-63-105 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6362<br>TO: PNL-CL<br>2 #12 >> GUH-6362 POWER | |
| L-63-106 | 63E11 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6363<br>TO: PNL-CL<br>2 #12 >> GUH-6363 POWER | |
| L-63-107 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6364<br>TO: PNL-CL<br>2 #12 >> GUH-6364 POWER | |
| L-63-108 | 63E05 | 1" | 3 | #6 | XHHW-2 | 1 | #10 | XHHW-2 | FR: UPS-CL<br>TO: UPS BYPASS DISC<br>3 #6 >> UPS-CL (BYPASS) POWER | |
| L-63-109 | 63E05 | 1" | 3 | #6 | XHHW-2 | 1 | #10 | XHHW-2 | FR: UPS BYPASS DISC<br>TO: PNL-CL<br>3 #6 >> UPS BYPASS DISC POWER | |
| L-63-110 | 63E05 | 3" | 4 | 250 | XHHW-2 | 1 | #2 | XHHW-2 | FR: PNL-CL<br>TO: XFMR-CL<br>4 250 >> PNL-CL POWER | |
| L-63-111 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: TWH-6365<br>TO: PNL-CL<br>2 #12 >> TWH-6365 POWER | |
| L-63-112 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: TWH-6366<br>TO: PNL-CL<br>2 #12 >> TWH-6366 POWER | |
| L-63-113 | 63E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: TWH-6367<br>TO: PNL-CL<br>2 #12 >> TWH-6367 POWER | |
| L-63-120 | 63E05 | 1" | 3 | #6 | XHHW-2 | 1 | #10 | XHHW-2 | FR: PNL-UPS-CL<br>TO: UPS-CL<br>3 #6 >> PNL-UPS-CL POWER | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

ENGINEER MJG
REVISION
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| N-63-100 | 63E05 | 1" | 3 | | CAT6 | 1 | #14 | XHHW-2 | FR: MCC-CL<br>TO: RTU-CL<br>1 CAT6 >> SSM-6301 POWER MONITOR NETWORK<br>1 CAT6 >> RVSS-6391 NETWORK<br>1 CAT6 >> RVSS-6392 NETWORK | |
| N-63-101 | 63E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: LCP-6361<br>TO: RTU-CL<br>1 CAT6 >> LCP-6361 NETWORK | |
| N-63-102 | 63E05 | 4" | 1 | | 12/FO | 1 | #14 | XHHW-2 | FR: LOI-FB<br>TO: LCP-6361<br>1 12/FO >> LOI-FB NETWORK | |
| N-63-103 | 63E05 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: LOI-CL<br>TO: LCP-6361<br>1 CAT6 >> LOI-CL NETWORK | |
| N-63-611 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-63-621 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-63-631 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-63-641 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-63-651 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-63-661 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-63-671 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-63-681 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CL<br>1 PULL >> SPARE | |
| N-63-682 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CL<br>1 PULL >> SPARE | |
| N-63-683 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CL<br>1 PULL >> SPARE | |
| N-63-684 | 63E16 | 1" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CL<br>1 PULL >> SPARE | |
| P-63-001 | 63E08 | 1" | 3 | #6 | XHHW-2 | 1 | #8 | XHHW-2 | FR: BLR-6391<br>TO: MCC-CL<br>3 #6 >> BLR-6391 POWER | |
| P-63-002 | 63E08 | 1" | 3 | #6 | XHHW-2 | 1 | #8 | XHHW-2 | FR: BLR-6392<br>TO: MCC-CL<br>3 #6 >> BLR-6392 POWER | |
| P-63-003 | 63E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PPU-6353<br>TO: DISC-6353<br>3 #12 >> PPU-6353 POWER | |
| P-63-004 | 63E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6353<br>TO: PP-CL<br>3 #12 >> DISC-6353 POWER | |
| P-63-005 | 63E12 | 0.75" | 3 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: MAU-6354<br>TO: PP-CL<br>3 #10 >> MAU-6354 POWER | |

# CONDUIT SCHEDULE AREA 63

**JVWTP FILTER AND CHEMICAL FEED UPGRADES**

**CHLORINE BUILDING**

ENGINEER: MJG
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-63-006 | 63E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: EF-6355<br>TO: MCC-CL<br>3 #12 >> EF-6355 POWER | |
| P-63-007 | 63E12 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: EF-6356<br>TO: MCC-CL<br>3 #12 >> EF-6356 POWER | |
| P-63-008 | 63E05 | 0.75" | 3 | #8 | XHHW-2 | 1 | #10 | XHHW-2 | FR: UPS-CL<br>TO: MCC-CL<br>3 #8 >> UPS (MAIN) POWER | |
| P-63-009 | 63E05 | 2.5" | 3 | 250 | XHHW-2 | 1 | #4 | XHHW-2 | FR: PP-CL<br>TO: MCC-CL<br>3 250 >> PP-CL POWER | |
| P-63-010 | 63E05 | 2" | 3 | #4/0 | XHHW-2 | 1 | #4 | XHHW-2 | FR: XFMR-CL<br>TO: MCC-CL<br>3 #4/0 >> XFMR-CL POWER | |
| P-63-011 | 63E09 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: CHLORINE BRIDGE CRANE<br>TO: BRIDGE CRANE DISCONNECT<br>3 #12 >> CHLORINE BRIDGE CRANE POWER | |
| P-63-012 | 63E09 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: BRIDGE CRANE DISCONNECT<br>TO: MCC-CL<br>3 #12 >> BRIDGE CRANE DISCONNECT POWER | |
| P-63-013 | 63E09 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: OHD-6311<br>TO: DISC-6311<br>3 #12 >> OHD-6311 POWER | |
| P-63-014 | 63E09 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6311<br>TO: PP-CL<br>3 #12 >> DISC-6311 POWER | |
| P-63-015 | 63E10 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: OHD-6312<br>TO: DISC-6312<br>3 #12 >> OHD-6312 POWER | |
| P-63-016 | 63E10 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6312<br>TO: PP-CL<br>3 #12 >> DISC-6312 POWER | |
| S-63-001 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6301<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6301 SIGNAL<br>2 #14 >> WIT-6301 (24VDC) POWER | |
| S-63-002 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6302<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6302 SIGNAL<br>2 #14 >> WIT-6302 (24VDC) POWER | |
| S-63-003 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6303<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6303 SIGNAL<br>2 #14 >> WIT-6303 (24VDC) POWER | |
| S-63-004 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6304<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6304 SIGNAL<br>2 #14 >> WIT-6304 (24VDC) POWER | |
| S-63-005 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6305<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6305 SIGNAL<br>2 #14 >> WIT-6305 (24VDC) POWER | |
| S-63-006 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6306<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6306 SIGNAL<br>2 #14 >> WIT-6306 (24VDC) POWER | |
| S-63-007 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6307<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6307 SIGNAL<br>2 #14 >> WIT-6307 (24VDC) POWER | |
| S-63-008 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6308<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6308 SIGNAL<br>2 #14 >> WIT-6308 (24VDC) POWER | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

ENGINEER: MJG
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-63-009 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6309<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6309 SIGNAL<br>2 #14 >> WIT-6309 (24VDC) POWER | |
| S-63-010 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6310<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6310 SIGNAL<br>2 #14 >> WIT-6310 (24VDC) POWER | |
| S-63-011 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6311<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6311 SIGNAL<br>2 #14 >> WIT-6311 (24VDC) POWER | |
| S-63-012 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6312<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6312 SIGNAL<br>2 #14 >> WIT-6312 (24VDC) POWER | |
| S-63-013 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6313<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6313 SIGNAL<br>2 #14 >> WIT-6313 (24VDC) POWER | |
| S-63-014 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6314<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6314 SIGNAL<br>2 #14 >> WIT-6314 (24VDC) POWER | |
| S-63-015 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6315<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6315 SIGNAL<br>2 #14 >> WIT-6315 (24VDC) POWER | |
| S-63-016 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6316<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6316 SIGNAL<br>2 #14 >> WIT-6316 (24VDC) POWER | |
| S-63-017 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6317<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6317 SIGNAL<br>2 #14 >> WIT-6317 (24VDC) POWER | |
| S-63-018 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6318<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6318 SIGNAL<br>2 #14 >> WIT-6318 (24VDC) POWER | |
| S-63-019 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6319<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6319 SIGNAL<br>2 #14 >> WIT-6319 (24VDC) POWER | |
| S-63-020 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6320<br>TO: RTU-CL<br>1 2/CS-#16 >> WIT-6320 SIGNAL<br>2 #14 >> WIT-6320 (24VDC) POWER | |
| S-63-021 | 63E06 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6311<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6311 SIGNAL<br>2 #14 >> AIT-6311 (24VDC) POWER | |
| S-63-022 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6312<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6312 SIGNAL<br>2 #14 >> AIT-6312 (24VDC) POWER | |
| S-63-023 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6313<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6313 SIGNAL<br>2 #14 >> AIT-6313 (24VDC) POWER | |
| S-63-024 | 63E03 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6314<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6314 SIGNAL<br>2 #14 >> AIT-6314 (24VDC) POWER | |

# CONDUIT SCHEDULE AREA 63

## JVWTP FILTER AND CHEMICAL FEED UPGRADES

## CHLORINE BUILDING

ENGINEER MJG
REVISION
DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-63-025 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6315<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6315 SIGNAL<br>2 #14 >> AIT-6315 (24VDC) POWER | |
| S-63-026 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6316<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6316 SIGNAL<br>2 #14 >> AIT-6316 (24VDC) POWER | |
| S-63-027 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6317<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6317 SIGNAL<br>2 #14 >> AIT-6317 (24VDC) POWER | |
| S-63-028 | 63E07 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6318<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6318 SIGNAL<br>2 #14 >> AIT-6318 (24VDC) POWER | |
| S-63-031 | 63E09 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6321<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6321 SIGNAL<br>2 #14 >> AIT-6321 (24VDC) POWER | |
| S-63-032 | 63E10 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6322<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6322 SIGNAL<br>2 #14 >> AIT-6322 (24VDC) POWER | |
| S-63-033 | 63E09 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6323<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6323 SIGNAL<br>2 #14 >> AIT-6323 (24VDC) POWER | |
| S-63-034 | 63E10 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6324<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6324 SIGNAL<br>2 #14 >> AIT-6324 (24VDC) POWER | |
| S-63-035 | 63E08 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6391<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6391 SIGNAL<br>2 #14 >> AIT-6391 (24VDC) POWER | |
| S-63-036 | 63E08 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6392<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6392 SIGNAL<br>2 #14 >> AIT-6392 (24VDC) POWER | |
| S-63-037 | 63E02 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6331<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6331 SIGNAL<br>2 #14 >> AIT-6331 (24VDC) POWER | |
| S-63-038 | 63E08 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PDIT-6391<br>TO: RTU-CL<br>1 2/CS-#16 >> PDIT-6391 SIGNAL | |
| S-63-039 | 63E08 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PDIT-6392<br>TO: RTU-CL<br>1 2/CS-#16 >> PDIT-6392 SIGNAL | |
| S-63-042 | 63E04 | 0.75" | 2<br>1 | #14<br>2/CS-#16 | XHHW-2 | 1 | #14 | XHHW-2 | FR: AIT-6342<br>TO: LCP-6361 (RTU-CLIP)<br>1 2/CS-#16 >> AIT-6342 SIGNAL<br>2 #14 >> AIT-6342 (24VDC) POWER | |
| S-63-051 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6331<br>TO: RTU-CL<br>1 2/CS-#16 >> VCP-6331 SIGNAL | |
| S-63-052 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6332<br>TO: RTU-CL<br>1 2/CS-#16 >> VCP-6332 SIGNAL | |
| S-63-053 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6333<br>TO: RTU-CL<br>1 2/CS-#16 >> VCP-6333 SIGNAL | |
| S-63-054 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6334<br>TO: RTU-CL<br>1 2/CS-#16 >> VCP-6334 SIGNAL | |

# CONDUIT SCHEDULE AREA 63

**JVWTP FILTER AND CHEMICAL FEED UPGRADES**

**CHLORINE BUILDING**

| | |
|---|---|
| ENGINEER | MJG |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-63-055 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6335<br>TO: RTU-CL<br>1 2/CS-#16 >> VCP-6335 SIGNAL | |
| S-63-056 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6336<br>TO: RTU-CL<br>1 2/CS-#16 >> VCP-6336 SIGNAL | |
| S-63-058 | 63E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TE-6359<br>TO: TIT-6359<br>1 2/CS-#16 >> TE-6359 SIGNAL | |
| S-63-059 | 63E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TIT-6359<br>TO: RTU-CL<br>1 2/CS-#16 >> TIT-6359 SIGNAL | |
| S-63-060 | 63E07 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TE-6357<br>TO: TIT-6357<br>1 2/CS-#16 >> TE-6357 SIGNAL | |
| S-63-061 | 63E07 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TIT-6357<br>TO: RTU-CL<br>1 2/CS-#16 >> TIT-6357 SIGNAL | |
| S-63-062 | 63E10 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TE-6358<br>TO: TIT-6358<br>1 2/CS-#16 >> TE-6358 SIGNAL | |
| S-63-063 | 63E10 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TIT-6358<br>TO: RTU-CL<br>1 2/CS-#16 >> TIT-6358 SIGNAL | |
| S-63-064 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TE-6360<br>TO: TIT-6360<br>1 2/CS-#16 >> TE-6360 SIGNAL | |
| S-63-065 | 63E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TIT-6360<br>TO: RTU-CL<br>1 2/CS-#16 >> TIT-6360 SIGNAL | |

END OF CONDUIT SCHEDULE

END OF SECTION

## SECTION 16990G

## CONDUIT SCHEDULE
## AREA 65

## PART 1 GENERAL

### 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. CAT6: Category 6 Ethernet cable.
   5. MFR: Manufacturer or vendor furnished cable.
   6. PULL: Pull Rope.
   7. VFD: Shielded VFD cable with integral ground.

## PART 2 PRODUCTS

Not Used.

## PART 3 EXECUTION

### 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 65

## FILTER AND CHEMICAL FEED UPGRADES

## CAUSTIC SODA BUILDING

ENGINEER: CK
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-65-001 | 65E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6517<br>TO: RTU-CS<br>2 #14 >> FSH-6517 CONTROL | |
| C-65-005 | 65E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6516<br>TO: RTU-CS<br>2 #14 >> FSH-6516 HIGH FLOW CONTROL | |
| C-65-007 | 65E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: TSHL-6560<br>TO: LCP-6560<br>2 #14 >> TSHL-6560 CONTROL | |
| C-65-008 | 65E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSL-6560<br>TO: RTU-CS<br>4 #14 >> FSL-6560 LOW FLOW CONTROL | |
| C-65-009 | 65E02 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XS-6560<br>TO: LCP-6560<br>4 #14 >> XS-6560 CONTROL | |
| C-65-010 | 65E06 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MAU-6560<br>TO: RTU-CS<br>14 #14 >> MAU-6560 CONTROL | |
| C-65-015 | 65E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: TSHL-6551<br>TO: AHU-6551<br>2 #14 >> TSHL-6551 CONTROL | |
| C-65-016 | 65E02 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AHU-6551<br>TO: CU-6551<br>1 MFR >> AHU-6551 CONTROL | |
| C-65-017 | 65E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: TSHL-6552<br>TO: AHU-6552<br>2 #14 >> TSHL-6552 CONTROL | |
| C-65-018 | 65E02 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: AHU-6552<br>TO: CU-6552<br>1 MFR >> AHU-6552 CONTROL | |
| C-65-019 | 65E02 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PPU-6553<br>TO: RTU-CS<br>2 #14 >> PPU-6553 SMOKE SHUT DOWN<br>2 #14 >> PPU-6553 FAILED<br>2 #14 >> PPU-6553 RUNNING<br>2 #14 >> PPU-6553 DIRTY FILTER<br>2 #14 >> PPU-6553 LOW TEMP<br>2 #14 >> PPU-6553 START | |
| C-65-021 | 65E04 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6572<br>TO: RTU-CS<br>4 #14 >> PISH-6572 HIGH PRESSURE CONTROL | |
| C-65-022 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6584<br>TO: RTU-CS<br>2 #14 >> SV-6584 OPEN CONTROL | |
| C-65-023 | 65E02 | 2" | 78 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MCC-CS<br>TO: RTU-CS<br>2 #14 >> MCC-CS SPD FAIL<br>8 #14 >> FVNR-6554 CONTROL<br>8 #14 >> FVNR-6555 CONTROL<br>8 #14 >> FVNR-6556 CONTROL<br>14 #14 >> VFD-6572 CONTROL<br>14 #14 >> VFD-6582 CONTROL<br>10 #14 >> FVNR-6511 CONTROL<br>10 #14 >> FVNR-6521 CONTROL<br>2 #14 >> SSM-6501<br>2 #14 >> SPD-6501 | |
| C-65-024 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6541<br>TO: RTU-CS<br>2 #14 >> PISH-6541 HIGH PRESSURE CONTROL | |
| C-65-025 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6562<br>TO: RTU-CS<br>2 #14 >> PISH-6562 HIGH PRESSURE CONTROL | |
| C-65-026 | 65E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6511<br>TO: MCC-CS<br>2 #14 >> PISH-6511 HIGH PRESSURE CONTROL | |
| C-65-027 | 65E05 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6521<br>TO: MCC-CS<br>4 #14 >> PISH-6521 HIGH PRESSURE CONTROL | |

# CONDUIT SCHEDULE AREA 65

## FILTER AND CHEMICAL FEED UPGRADES

## CAUSTIC SODA BUILDING

ENGINEER CK

REVISION

DATE 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-65-029 | 65E03 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6560<br>TO: RTU-CS<br>14 #14 >> LCP-6560 CONTROL | |
| C-65-031 | 65E06 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: RTU-CS<br>TO: LCP-6555<br>2 #14 >> LCP-6555 AUTO CONTROL | |
| C-65-032 | 65E04<br>65E06 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XS-6556<br>TO: MCC-CS<br>4 #14 >> XS-6556 SMOKE DETECTOR CONTROL | |
| C-65-035 | 65E04 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6541<br>TO: RTU-CS<br>14 #14 >> PMP-6541 CONTROL | |
| C-65-036 | 65E04 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6562<br>TO: RTU-CS<br>14 #14 >> PMP-6562 CONTROL | |
| C-65-039 | 65E06 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6554<br>TO: MCC-CS<br>7 #14 >> LCP-6554 FVNR-6554 CONTROL | |
| C-65-040 | 65E06 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6555<br>TO: MCC-CS<br>7 #14 >> LCP-6555 FVNR-6555 CONTROL | |
| C-65-042 | 65E06 | 0.75" | 7 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6556<br>TO: MCC-CS<br>7 #14 >> LCP-6556 FVNR-6556 CONTROL | |
| C-65-044 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6582<br>TO: MCC-CS<br>2 #14 >> PISH-6582 VFD-6582 CONTROL | |
| C-65-045 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6582<br>TO: RTU-CS<br>2 #14 >> PISH-6582N HIGH PRESS CONTROL | |
| C-65-047 | 65E05 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6521<br>TO: MCC-CS<br>2 #14 >> PISH-6521 FVNR-6521 CONTROL | |
| C-65-049 | 65E05 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: TIT-6557<br>TO: TE-6557<br>1 MFR >> TIT-6557 CONTROL | |
| C-65-050 | 65E03 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: TIT-6568<br>TO: TE-6568<br>1 MFR >> TIT-6568 CONTROL | |
| C-65-051 | 65E02 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: TIT-6559<br>TO: TE-6559<br>1 MFR >> TIT-6559 MFR CONTROL | |
| C-65-510 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6510<br>TO: RTU-CS<br>2 #14 >> FSH-6510 CONTROL | |
| C-65-534 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6534<br>TO: RTU-CS<br>2 #14 >> LSH-6534 CONTROL | |
| C-65-554 | 65E05 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XS-6554<br>TO: MCC-CS VIA FVNR-6554<br>4 #14 >> XS-6554 CONTROL | |
| C-65-555 | 65E05 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: XS-6555<br>TO: MCC-CS VIA FVNR-6555<br>4 #14 >> XS-6555 CONTROL | |
| C-65-584 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6584<br>TO: RTU-CS<br>2 #14 >> FSH-6584 CONTROL | |
| C-65-611 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 65-D101-01 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-65-621 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 65-D103-01 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |

# CONDUIT SCHEDULE AREA 65

## FILTER AND CHEMICAL FEED UPGRADES

## CAUSTIC SODA BUILDING

ENGINEER: CK
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-65-631 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 65-D102-01 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-65-650 | 65E04 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-6500<br>TO: RTU-CS<br>6 #14 >> LCP-6500 CONTROL | |
| L-65-007 | 65E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: RTU-CS<br>TO: PNL-UPS-CS<br>3 #12 >> RTU-CS POWER | |
| L-65-010 | 65E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6582<br>TO: MCC-CS<br>3 #12 >> PISH-6582 POWER | |
| L-65-011 | 65E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PNL-CS<br>TO: RTU-CS<br>3 #12 >> RTU-CS POWER | |
| L-65-012 | 65E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PNL-CS<br>TO: SECURITY PANEL<br>3 #12 >> RTU-CS POWER | |
| L-65-015 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: WIT-6531<br>TO: RTU-CS<br>2 #12 >> WIT-3631 POWER | |
| L-65-016 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6541<br>TO: RTU-CS<br>2 #12 >> PISH-6541 POWER | |
| L-65-017 | 65E04 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6562<br>TO: RTU-CS<br>2 #14 >> PISH-6562 HIGH PRESSURE CONTROL | |
| L-65-019 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6541<br>TO: PNL-CS<br>2 #12 >> PMP-6541 POWER | |
| L-65-020 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6562<br>TO: PNL-CS<br>2 #12 >> PMP-6562 POWER | |
| L-65-021 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FIT-6583<br>TO: RTU-CS<br>2 #12 >> FIT-6583 POWER | |
| L-65-022 | 65E05 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LSH-6514<br>TO: RTU-CS<br>2 #12 >> LSH-6514 POWER | |
| L-65-023 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FIT-6563<br>TO: RTU-CS<br>2 #12 >> FIT-6563 POWER | |
| L-65-501 | 65E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6501<br>TO: PNL-CS<br>2 #10 >> HTU-6501 POWER | |
| L-65-502 | 65E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6502<br>TO: PNL-CS<br>2 #10 >> HTU-6502 POWER | |
| L-65-503 | 65E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6503<br>TO: PNL-CS<br>2 #10 >> HTU-6503 POWER | |
| L-65-030 | 65E02 | 1" | 3 | #6 | XHHW-2 | 1 | #10 | XHHW-2 | FR: PNL-UPS-CS<br>TO: UPS-CS<br>3 #6 >> PNL-UPS-CS POWER | |
| L-65-031 | 65E02 | 1" | 3 | #6 | XHHW-2 | 1 | #10 | XHHW-2 | FR: UPS-CS<br>TO: UPS BYPASS DISC<br>3 #6 >> UPS-CS (BYPASS) POWER | |
| L-65-032 | 65E02 | 1" | 3 | #6 | XHHW-2 | 1 | #10 | XHHW-2 | FR: UPS BYPASS DISC<br>TO: PNL-CS<br>3 #6 >> UPS BYPASS DISC POWER | |
| L-65-501 | 65E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6501<br>TO: PNL-CS<br>2 #10 >> HTU-6501 CONTROLLER POWER | |

# CONDUIT SCHEDULE AREA 65

## FILTER AND CHEMICAL FEED UPGRADES

## CAUSTIC SODA BUILDING

| ENGINEER | CK |
|---|---|
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| L-65-502 | 65E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6502<br>TO: PNL-CS<br>2 #10 >> HTU-6502 CONTROLLER POWER | |
| L-65-503 | 65E05 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6503<br>TO: PNL-CS<br>2 #10 >> HTU-6503 CONTROLLER POWER | |
| L-65-510 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: HTU-6510<br>TO: PNL-CS<br>2 #12 >> HTU-6510 POWER | |
| L-65-511 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: HTU-6511<br>TO: PNL-CS<br>2 #12 >> HTU-6511 POWER | |
| L-65-531 | 65E04 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HTU-6531<br>TO: PNL-CS<br>2 #10 >> HTU-6531 CONTROLLER POWER | |
| L-65-534 | 65E04 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LSH-6534<br>TO: RTU-CS<br>2 #12 LSH-6534 POWER | |
| L-65-561 | 65E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6561<br>TO: PNL-CS<br>3 #12 >> GUH-561 POWER | |
| L-65-562 | 65E04 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6562<br>TO: PNL-CS<br>3 #12 >> GUH-6562 POWER | |
| L-65-563 | 65E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6563<br>TO: PNL-CS<br>3 #12 >> GUH-563 POWER | |
| L-65-564 | 65E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: GUH-6564<br>TO: PNL-CS<br>3 #12 >> GUH-564 POWER | |
| L-65-650 | 65E04 | 0.75" | 3 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: LCP-6500<br>TO: RTU-CS<br>3 #10 >> LCP-6500 POWER | |
| N-65-001 | 65E02 | 0.75" | 1 | | CAT6 | 1 | #14 | XHHW-2 | FR: MCC-CS<br>TO: RTU-CS<br>1 CAT6 >> MCC-CS POWER MONITOR NETWORK | |
| N-65-611 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-65-621 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-65-631 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CS<br>1 PULL >> SPARE | |
| N-65-641 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CS<br>1 PULL >> SPARE | |
| N-65-651 | 65E10 | 1" | 1 | PULL | ROPE | | | | FR: WIRELESS NETWORK J-BOX<br>TO: RTU-CS<br>1 PULL >> SPARE | |
| P-65-001 | 65E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6554<br>TO: EF-6554<br>3 #12 >> EF-6554 POWER | P-65-002 |
| P-65-002 | 65E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6554<br>TO: MCC-CS<br>3 #12 >> EF-6554 POWER | P-65-001 |
| P-65-004 | 65E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: EF-6555<br>TO: DISC-6555<br>3 #12 >> EF-6555 POWER | P-65-024 |
| P-65-005 | 65E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SF-6556<br>TO: DISC-6556<br>3 #12 >> SF-6556 POWER | P-65-006 |

# CONDUIT SCHEDULE AREA 65

## FILTER AND CHEMICAL FEED UPGRADES

## CAUSTIC SODA BUILDING

ENGINEER: CK
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-65-006 | 65E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6556<br>TO: MCC-CS<br>3 #12 >> SF-6556 POWER | P-65-005 |
| P-65-007 | 65E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PPU-6553<br>TO: DISC-6553<br>3 #12 >> PPU-6553 POWER | P-65-008 |
| P-65-008 | 65E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6553<br>TO: MCC-CS<br>3 #12 >> PPU-6553 POWER | P-65-007 |
| P-65-013 | 65E03 | 0.75" | 3 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: LCP-6560<br>TO: PP-CS<br>3 #10 >> LCP-6560 POWER | |
| P-65-016 | 65E04 | 1.5" | 1<br>4 | 3/C-#12:VFD<br>#14 | VFD<br>XHHW-2 | | | INTEGRAL | FR: PMP-6572<br>TO: MCC-CS<br>1 3/C-#12:VFD >> PMP-6572 POWER<br>2 #14 >> PMP-6572 MWH CONTROL<br>2 #14 >> PMP-6572 TSH CONTROL | |
| P-65-018 | 65E04 | 1.5" | 1<br>4 | 3/C-#12:VFD<br>#14 | VFD<br>XHHW-2 | | | INTEGRAL | FR: PMP-6582<br>TO: MCC-CS<br>1 3/C-#12:VFD >> PMP-6582 POWER<br>2 #14 >> PMP-6582 MWH CONTROL<br>2 #14 >> PMP-6582 TSH CONTROL | |
| P-65-020 | 65E05 | 0.75" | 3<br>4 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6511<br>TO: LCP-6511<br>3 #12 >> PMP-6511 POWER<br>2 #14 >> PMP-6511 MWH CONTROL<br>2 #14 >> PMP-6511 TSH CONTROL | |
| P-65-021 | 65E05 | 0.75" | 3<br>4 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6521<br>TO: LCP-6521<br>3 #12 >> PMP-6521 POWER<br>2 #14 >> PMP-6521 MWH CONTROL<br>2 #14 >> PMP-6521 TSH CONTROL | |
| P-65-024 | 65E06 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6555<br>TO: MCC-CS<br>3 #12 >> EF-6555 POWER | P-65-004 |
| P-65-025 | 65E06 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HP-6551<br>TO: DISC-6551<br>2 #10 >> HP-6551 POWER | P-65-026 |
| P-65-026 | 65E06 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: DISC-6551<br>TO: PNL-CS<br>2 #10 >> HP-6551 POWER | P-65-025 |
| P-65-027 | 65E06 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: HP-6552<br>TO: DISC-6552<br>2 #10 >> HP-6552 POWER | P-65-028 |
| P-65-028 | 65E06 | 0.75" | 2 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: DISC-6552<br>TO: PNL-CS<br>2 #10 >> HP-6552 POWER | P-65-027 |
| P-65-030 | 65E02 | 2" | 3 | #4/0 | XHHW-2 | 1 | #4 | XHHW-2 | FR: XFMR-CS<br>TO: MCC-CS<br>3 #4/0 >> XFMR-CS POWER | |
| P-65-031 | 65E02 | 3" | 4 | 250 | XHHW-2 | 1 | #2 | XHHW-2 | FR: PNL-CS<br>TO: XFMR-CS<br>4 250 >> PNL-CS POWER | |
| P-65-040 | 65E02 | 0.75" | 3 | #8 | XHHW-2 | 1 | #10 | XHHW-2 | FR: UPS-CS<br>TO: MCC-CS<br>3 #8 >> UPS-CS (MAIN) POWER | |
| P-65-045 | 65E02 | 1.5" | 3 | #2 | XHHW-2 | 1 | #8 | XHHW-2 | FR: PP-CS<br>TO: MCC-CS<br>3 #2 >> PP-CS POWER | |
| P-65-600 | 65E06 | 0.75" | 3 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: MAU-6560<br>TO: PP-CS<br>3 #10 >> MAU-6560 POWER | |
| S-65-001 | 65E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LSH-6514<br>TO: RTU-CS<br>1 2/CS-#16 >> LSH-6514 SIGNAL | |

| **CONDUIT SCHEDULE AREA 65** | | | | | | | | | ENGINEER | CK |
|---|---|---|---|---|---|---|---|---|---|---|
| **FILTER AND CHEMICAL FEED UPGRADES** | | | | | | | | | REVISION | |
| **CAUSTIC SODA BUILDING** | | | | | | | | | DATE | 2/11/25 |
| **CONDUIT** | | | **CONDUCTORS** | | | **GROUND** | | | | |
| **NUMBER** | **DWG** | **SIZE** | **#** | **SIZE** | **TYPE** | **#** | **SIZE** | **TYPE** | **DESCRIPTION** | **CONNECTING SEGMENTS** |
| S-65-002 | 65E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-6501<br>TO: RTU-CS<br>1 2/CS-#16 >> LIT-6501 SIGNAL | |
| S-65-003 | 65E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-6502<br>TO: RTU-CS<br>1 2/CS-#16 >> LIT-6502 SIGNAL | |
| S-65-004 | 65E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-6503<br>TO: RTU-CS<br>1 2/CS-#16 >> LIT-6503 SIGNAL | |
| S-65-005 | 65E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-6531<br>TO: RTU-CS<br>1 2/CS-#16 >> LIT-6531 SIGNAL | |
| S-65-006 | 65E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: WIT-3631<br>TO: RTU-CS<br>1 2/CS-#16 >> WIT-3631 SIGNAL | |
| S-65-007 | 65E05 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TIT-6557<br>TO: RTU-CL<br>1 2/CS-#16 >> TIT-6557 SIGNAL | |
| S-65-008 | 65E03 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TIT-6568<br>TO: RTU-CL<br>1 2/CS-#16 >> TIT-6568 SIGNAL | |
| S-65-009 | 65E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: TIT-6559<br>TO: RTU-CS<br>1 2/CS-#16 >> TIT-6559 SIGNAL | |
| S-65-010 | 65E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FIT-6563<br>TO: RTU-CS<br>1 2/CS-#16 >> FIT-6563 SIGNAL | |
| S-65-011 | 65E04 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: FIT-6583<br>TO: RTU-CS<br>1 2/CS-#16 >> FIT-6583 FLOW SIGNAL | |
| S-65-020 | 65E04 | 1" | 4 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PMP-6541<br>TO: RTU-CS<br>4 2/CS-#16 >> PMP-6541 SIGNAL | |
| S-65-025 | 65E04 | 1" | 4 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PMP-6562<br>TO: RTU-CS<br>4 2/CS-#16 >> PMP-6562 SIGNAL | |
| S-65-048 | 65E04 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: WE-6531<br>TO: WIT-6531<br>1 MFR >> WIT-6531 CONTROL | |
| S-65-650 | 65E04 | 1" | 3 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LCP-6500<br>TO: RTU-CS<br>3 2/CS-#16 >> LCP-6500 SIGNAL | |

END OF CONDUIT SCHEDULE

END OF SECTION

## SECTION 16990H

## CONDUIT SCHEDULE
## AREA 68

## PART 1 GENERAL

### 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. VFD: Shielded VFD cable with integral ground.

## PART 2 PRODUCTS

Not Used.

## PART 3 EXECUTION

### 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 68

## FILTER AND CHEMICAL FEED UPGRADES

## PAC AREA

| | |
|---|---|
| ENGINEER | SKB |
| REVISION | |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-68-125 | 68E02 | 1.5" | 44 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PAC SILO 1 CONTROL J-BOX<br>TO: VCP-6800<br>2 #14 >> LIT-6801 POWER<br>2 #14 >> PDAH-6802 CONTROL<br>2 #14 >> LSH-6801 CONTROL<br>2 #14 >> LSL-6801 CONTROL<br>2 #14 >> LSH-6803 CONTROL<br>2 #14 >> LSHL-6803 CONTROL<br>3 #14 >> PISL-6802 CONTROL<br>3 #14 >> PISL-6804 CONTROL<br>3 #14 >> PISL-6825 CONTROL<br>3 #14 >> PISL-6811 CONTROL<br>3 #14 >> PISL-6812 CONTROL<br>2 #14 >> LSH-6810 CONTROL<br>3 #14 >> PISL-6814 CONTROL<br>12 #14 >> SPARE | |
| C-68-128 | 68E02 | 2" | 20<br>40 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PAC SILO 1 CONTROL J-BOX<br>TO: VCP-6800<br>16 #14 >> VCP-6801 CONTROL<br>2 #12 >> SV1-6801 CONTROL<br>2 #12 >> SV2-6801 CONTROL<br>2 #12 >> SV3-6801 CONTROL<br>2 #12 >> SV4-6801 CONTROL<br>2 #12 >> SV-6802 CONTROL<br>2 #12 >> SV1-6804 CONTROL<br>2 #12 >> SV2-6804 CONTROL<br>2 #12 >> SV-6811 CONTROL<br>2 #12 >> SV-6813A CONTROL<br>2 #12 >> SV-6813B CONTROL<br>24 #14 >> SPARE | |
| C-68-325 | 68E02 | 1.5" | 44 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PAC SILO 2 CONTROL J-BOX<br>TO: VCP-6830<br>2 #14 >> LIT-6831 POWER<br>2 #14 >> PDAH-6832 CONTROL<br>2 #14 >> LSH-6831 CONTROL<br>2 #14 >> LSL-6831 CONTROL<br>2 #14 >> LSH-6833 CONTROL<br>2 #14 >> LSHL-6833 CONTROL<br>3 #14 >> PISL-6832 CONTROL<br>3 #14 >> PISL-6834 CONTROL<br>3 #14 >> PISL-6845 CONTROL<br>3 #14 >> PISL-6841 CONTROL<br>3 #14 >> PISL-6842 CONTROL<br>2 #14 >> LSH-6840 CONTROL<br>3 #14 >> PISL-6844 CONTROL<br>12 #14 >> SPARE | |
| C-68-328 | 68E02 | 2" | 20<br>40 | #12<br>#14 | XHHW-2<br>XHHW-2 | 1 | #12 | XHHW-2 | FR: PAC SILO 2 CONTROL J-BOX<br>TO: VCP-6830<br>16 #14 >> VCP-6831 CONTROL<br>2 #12 >> SV1-6831 CONTROL<br>2 #12 >> SV2-6831 CONTROL<br>2 #12 >> SV3-6831 CONTROL<br>2 #12 >> SV4-6831 CONTROL<br>2 #12 >> SV-6832 CONTROL<br>2 #12 >> SV1-6834 CONTROL<br>2 #12 >> SV2-6834 CONTROL<br>2 #12 >> SV-6841 CONTROL<br>2 #12 >> SV-6843A CONTROL<br>2 #12 >> SV-6843B CONTROL<br>24 #14 >> SPARE | |
| L-68-125 | 68E02 | 1" | 8 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: PAC SILO 1 120V J-BOX<br>TO: PPSC-PAC<br>2 #10 >> SILO 1 RECEPTACLES<br>2 #10 >> SILO 1 LIGHTS<br>4 #10 >> SPARE | |
| L-68-325 | 68E02 | 1" | 8 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: PAC SILO 2 120V J-BOX<br>TO: PPSC-PAC<br>2 #10 >> SILO 2 RECEPTACLES<br>2 #10 >> SILO 2 LIGHTS<br>4 #10 >> SPARE | |
| P-68-124 | 68E02 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PAC SILO 1 480V J-BOX<br>TO: VCP2-6802<br>1 3/C-#12:VFD >> FDR-6803 POWER | |

# CONDUIT SCHEDULE AREA 68

## FILTER AND CHEMICAL FEED UPGRADES

## PAC AREA

ENGINEER: SKB
REVISION:
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| P-68-125 | 68E02 | 1.5" | 6<br>6<br>6 | #10<br>#12<br>#14 | XHHW-2<br>XHHW-2<br>XHHW-2 | 1 | #10 | XHHW-2 | FR: PAC SILO 1 480V J-BOX<br>TO: VCP2-6802<br>2 #12 >> MWH-6803 POWER<br>2 #14 >> TSH-6803 CONTROL<br>3 #10 >> FDR-6810 POWER<br>2 #12 >> MWH-6810 POWER<br>2 #14 >> TSH-6810 CONTROL<br>3 #10 >> BLO-6802 POWER<br>2 #12 >> MWH-6802 POWER<br>2 #14 >> TSH-6802 CONTROL | |
| P-68-128 | 68E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PAC SILO 1 480V J-BOX<br>TO: PP-PAC<br>3 #12 >> PAC SILO 1 HEATER | |
| P-68-324 | 68E02 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PAC SILO 2 480V J-BOX<br>TO: VCP2-6832<br>1 3/C-#12:VFD >> FDR-6833 POWER | |
| P-68-325 | 68E02 | 1.5" | 6<br>6<br>6 | #10<br>#12<br>#14 | XHHW-2<br>XHHW-2<br>XHHW-2 | 1 | #10 | XHHW-2 | FR: PAC SILO 2 480V J-BOX<br>TO: VCP2-6832<br>2 #12 >> MWH-6833 POWER<br>2 #14 >> TSH-6833 CONTROL<br>3 #10 >> FDR-6840 POWER<br>2 #12 >> MWH-6840 POWER<br>2 #14 >> TSH-6840 CONTROL<br>3 #10 >> BLO-6832 POWER<br>2 #12 >> MWH-6832 POWER<br>2 #14 >> TSH-6832 CONTROL | |
| P-68-328 | 68E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PAC SILO 2 480V J-BOX<br>TO: PP-PAC<br>3 #12 >> PAC SILO 2 HEATER | |
| S-68-125 | 68E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PAC SILO 1 SIGNAL J-BOX<br>TO: VCP-6800<br>1 2/CS-#16 >> VCP-6801 SIGNAL<br>1 2/CS-#16 >> LIT-6801 SIGNAL | |
| S-68-325 | 68E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: PAC SILO 2 SIGNAL J-BOX<br>TO: VCP-6830<br>1 2/CS-#16 >> VCP-6831 SIGNAL<br>1 2/CS-#16 >> LIT-6831 SIGNAL | |

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990J

CONDUIT SCHEDULE
AREA 69

# PART 1 GENERAL

## 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. CAT6: Category 6 Ethernet cable.
   5. MFR: Manufacturer or vendor furnished cable.
   6. PULL: Pull Rope.
   7. RS-485 RS-485 cable.
   8. VFD: Shielded VFD cable with integral ground.

# PART 2 PRODUCTS

Not Used.

# PART 3 EXECUTION

## 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 69

## FILTER AND CHEMICAL FEED UPGRADES

## PEA DRY FEED AREA

| | |
|---|---|
| **ENGINEER** | **CK** |
| **REVISION** | **0** |
| **DATE** | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-69-004 | 69E02 | 2.5" | 82 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6901<br>TO: RTU-PEA<br>2 #14 >> LSL-6901 CONTROL<br>2 #14 >> LSH-6901 CONTROL<br>10 #14 >> FV-6902 CONTROL<br>10 #14 >> FV-6903 CONTROL<br>10 #14 >> FV-6904 CONTROL<br>4 #14 >> MIX-6905 COTROL<br>2 #14 >> LSHH-6905 CONTROL<br>2 #14 >> BLO-6911 CONTROL<br>2 #14 >> LSL-6911 CONTROL<br>2 #14 >> LSH-6911 CONTROL<br>10 #14 >> FV-6912 CONTROL<br>10 #14 >> FV-6913 CONTROL<br>10 #14 >> FV-6914 CONTROL<br>4 #14 >> MIX-6915 CONTROL<br>2 #14 >> LSHH-6915 CONTROL | |
| C-69-011 | 69E02 | 1.5" | 36 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: JB-6911<br>TO: VCP-6911<br>2 #14 >> BLO-6911 CONTROL<br>2 #14 >> LSL-6911 CONTRL<br>2 #14 >> LSH-6911 CONTROL<br>10 #14 >> FV-6912 CONTROL<br>10 #14 >> FV-6913 CONTROL<br>10 #14 >> FV-6914 CONTROL | |
| C-69-016 | 69E03 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6916<br>TO: RTU-PEA<br>14 #14 >> PMP-6916 CONTROL | |
| C-69-018 | 69E03 | 0.75" | 1 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6918<br>TO: RTU-PEA<br>1 #14 >> FIT-6918 24 VDC POWER | |
| C-69-019 | 69E03 | 0.75" | 1 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6919<br>TO: RTU-PEA<br>1 #14 >> FIT-6919 24 VDC POWER | |
| C-69-021 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6921<br>TO: MCC-PEA VIA VFD-6921<br>2 #14 >> MWH-6921 CONTROL<br>2 #14 >> TSH-6921 CONTROL | |
| C-69-026 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6926<br>TO: MCC-PEA VIA VFD-6926<br>2 #14 >> MWH-6926 CONTROL<br>2 #14 >> TSH-6926 CONTROL | |
| C-69-027 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6927<br>TO: RTU-PEA<br>2 #14 >> SV-6927 CONTROL<br>2 #14 >> SV-6927 24 VDC POWER | |
| C-69-028 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6928<br>TO: RTU-PEA<br>2 #14 >> SV-6928 CONTROL<br>2 #14 >> SV-6928 24 VDC POWER | |
| C-69-029 | 69E03 | 0.75" | 1 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6929<br>TO: RTU-PEA<br>1 #14 >> FIT-6929 24 VDC POWER | |
| C-69-035 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6935<br>TO: RTU-PEA<br>2 #14 >> SV-6935 OPEN CONTROL<br>2 #14 >> SV-6935 24 VDC POWER<br>14 | |
| C-69-037 | 69E03 | 0.75" | 2<br>1 | #14 | XHHW-2<br>CAT6 | 1 | #14 | XHHW-2 | FR: FIT-6937<br>TO: RTU-PEA<br>2 #14 >> FIT-6937 24 VDC POWER<br>1 CAT6 >> FIT-6937 NETWORK | |
| C-69-038 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6938<br>TO: RTU-PEA<br>2 #14 >> FIT-6938 24VDC POWER | |
| C-69-041 | | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6941<br>TO: RTU-PEA<br>2 #14 >> SV-6941 CONTROL<br>2 #14 >> SV-6941 24 VDC POWER | |
| C-69-048 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6948<br>TO: RTU-PEA<br>2 #14 >> FIT-6948 24VDC POWER | |

# CONDUIT SCHEDULE AREA 69

## FILTER AND CHEMICAL FEED UPGRADES

## PEA DRY FEED AREA

| | |
|---|---|
| ENGINEER | CK |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-69-049 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6949<br>TO: RTU-PEA<br>2 #14 >> FIT-6949 24VDC POWER | |
| C-69-054 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6934<br>TO: RTU-PEA<br>2 #14 >> SV-6934 CONTROL<br>2 #14 >> SV-6934 24 VDC POWER | |
| C-69-055 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6940<br>TO: RTU-PEA<br>2 #14 >> SV-6940 CONTROL<br>2 #14 >> SV-6940 24 VDC POWER | |
| C-69-056 | 69E03 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6956<br>TO: RTU-PEA<br>14 #14 >> PMP-6956 CONTROL | |
| C-69-057 | | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: SV-6957<br>TO: RTU-PEA<br>2 #14 >> SV-6957 CONTROL<br>2 #14 >> SV-6957 24 VDC POWER | |
| C-69-058 | | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6958<br>TO: RTU-PEA<br>2 #14 >> FIT-6958 CONTROL | |
| C-69-101 | 69E02 | 1.5" | 36 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: JB-6901<br>TO: VCP-6901<br>2 #14 >> BLO-6901 CONTROL<br>2 #14 >> LSL-6901 CONTRL<br>2 #14 >> LSH-6901 CONTROL<br>10 #14 >> FV-6902 CONTROL<br>10 #14 >> FV-6903 CONTROL<br>10 #14 >> FV-6904 CONTROL | |
| C-69-105 | 69E03 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: JB-6905<br>TO: VCP-6901<br>4 #14 >> MIX-6905 CONTROL<br>2 #14 >> LSHH-6905 CONTROL<br>2 #14 >> PDIT-6905 CONTROL<br>4 #14 >> SPARE | |
| C-69-111 | 69E03 | 1" | 14 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6911<br>TO: RTU-PEA<br>14 #14 >> PMP-6911 CONTROL | |
| C-69-115 | 69E03 | 1" | 12 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: JB-6915<br>TO: VCP-6901<br>4 #14 >> MIX-6915 CONTROL<br>2 #14 >> LSHH-6915 CONTROL<br>2 #14 >> PDIT-6915 CONTROL<br>4 #14 >> SPARE | |
| C-69-116 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6916<br>TO: RTU-PEA<br>2 #14 >> PISH-6916 CONTROL<br>2 #14 >> PISH-6916 24 VDC POWER | |
| C-69-121 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6921<br>TO: MCC-PEA VIA VFD-6921<br>2 #14 >> PISH-6921 CONTROL | |
| C-69-126 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6926<br>TO: MCC-PEA VIA VFD-6926<br>2 #14 >> PISH-6926 CONTROL | |
| C-69-128 | 69E03 | 0.75" | 1 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6928<br>TO: RTU-PEA<br>1 #14 >> FIT-6928 24 VDC POWER | |
| C-69-131 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6931<br>TO: MCC-PEA VIA VFD-6931<br>2 #14 >> MWH-6931<br>2 #14 >> TSH-6931 | |
| C-69-136 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6936<br>TO: MCC-PEA VIA VFD-6936<br>2 #14 >> MWH-6936<br>2 #14 >> TSH-6936 | |

# CONDUIT SCHEDULE AREA 69

## FILTER AND CHEMICAL FEED UPGRADES

## PEA DRY FEED AREA

| | |
|---|---|
| ENGINEER | CK |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-69-141 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6941<br>TO: MCC-PEA VIA VFD-6941<br>2 #14 >> MWH-6941<br>2 #14 >> TSH-6941 | |
| C-69-146 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6946<br>TO: MCC-PEA VIA VFD-6946<br>2 #14 >> MWH-6946<br>2 #14 >> TSH-6946 | |
| C-69-151 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-6951<br>TO: MCC-PEA VIA VFD-6951<br>2 #14 >> MWH-6951<br>2 #14 >> TSH-6951 | |
| C-69-156 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6956<br>TO: RTU-PEA<br>2 #14 >> PISH-6956 CONTROL<br>2 #14 >> PISH-6956 24 VDC POWER | |
| C-69-211 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6911<br>TO: RTU-PEA<br>2 #14 >> PISH-6911 CONTROL<br>2 #14 >> PISH-6911 24 VDC POWER | |
| C-69-221 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6921<br>TO: RTU-PEA<br>2 #14 >> PISH-6921 CONTROL | |
| C-69-226 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6926<br>TO: RTU-PEA<br>2 #14 >> PISH-6926 CONTROL | |
| C-69-231 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6931<br>TO: RTU-PEA<br>2 #14 >> PISH-6931 CONTROL | |
| C-69-236 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6936<br>TO: RTU-PEA<br>2 #14 >> PISH-6936 CONTROL | |
| C-69-241 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6941<br>TO: RTU-PEA<br>2 #14 >> PISH-6941 CONTROL | |
| C-69-246 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6946<br>TO: RTU-PEA<br>2 #14 >> PISH-6946 CONTROL | |
| C-69-251 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6951<br>TO: RTU-PEA<br>2 #14 >> PISH-6951 CONTROL | |
| C-69-331 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6931<br>TO: MCC-PEA VIA VFD-6931<br>2 #14 >> PISH-6931 CONTROL | |
| C-69-336 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6936<br>TO: MCC-PEA VIA VFD-6936<br>2 #14 >> PISH-6936 CONTROL | |
| C-69-341 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6941<br>TO: MCC-PEA VIA VFD-6941<br>2 #14 >> PISH-6941 CONTROL | |
| C-69-346 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6946<br>TO: MCC-PEA VIA VFD-6946<br>2 #14 >> PISH-6946 CONTROL | |
| C-69-351 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-6951<br>TO: MCC-PEA VIA VFD-6951<br>2 #14 >> PISH-6951 CONTROL | |
| C-69-405 | 69E03 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: WE-6905<br>TO: WIT-6905<br>1 MFR >> WE-6905 CONTROL | |
| C-69-415 | 69E03 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: WE-6915<br>TO: WIT-6915<br>1 MFR >> 23-6915 CONTROL | |

# CONDUIT SCHEDULE AREA 69

## FILTER AND CHEMICAL FEED UPGRADES

## PEA DRY FEED AREA

| ENGINEER | CK |
|---|---|
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-69-505 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6905<br>TO: RTU-PEA<br>2 #14 >> WIT-6905 24 VDC POWER | |
| C-69-515 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6915<br>TO: RTU-PEA<br>2 #14 >> WIT-6915 24 VDC POWER | |
| C-69-611 | 69E04 | 1" | 1 | PULL | ROPE | | | | FR: DOOR SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-69-621 | 69E04 | 1" | 1 | PULL | ROPE | | | | FR: DOOR 69-D101-03 SECURITY J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| C-69-710 | 69E02 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-7100<br>TO: RTU-PEA<br>6 #14 >> LCP-7100 CONTROL | |
| C-69-901 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-6901<br>TO: RTU-PEA<br>2 #14 >> FSH-6901 CONTROL | |
| C-69-903 | 69E03 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6903<br>TO: VCP-6901<br>6 #14 >> FV-6903 CONTROL | |
| C-69-904 | 69E03 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6904<br>TO: VCP-6901<br>6 #14 >> FV-6904 CONTROL | |
| C-69-905 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MIX-6905<br>TO: JB-6905<br>4 #14 >> MIX-6905 | |
| C-69-906 | 69E03 | 0.75" | 3 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6906<br>TO: VCP-6901<br>3 #14 >> FV-6906 CONTROL | |
| C-69-907 | 69E03 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6907<br>TO: RTU-PEA<br>2 #14 >> LSH-6907 CONTROL | |
| C-69-913 | 69E03 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6913<br>TO: VCP-6901<br>6 #14 >> FV-6913 CONTROL | |
| C-69-914 | 69E03 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6914<br>TO: VCP-6901<br>6 #14 >> FV-6914 CONTROL | |
| C-69-915 | 69E03 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MIX-6915<br>TO: JB-6915<br>4 #14 >> MIX-6915 | |
| C-69-916 | 69E03 | 0.75" | 3 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FV-6916<br>TO: VCP-6901<br>3 #14 >> FV-6916 CONTROL | |
| L-69-011 | 69E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-6911<br>TO: VCP-6911<br>2 #12 >> PMP-6911 POWER | |
| L-69-016 | 69E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6916<br>TO: PNL-PEA<br>2 #12 >> PMP-6916 POWER | |
| L-69-021 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6921<br>TO: MCC-PEA VIA VFD-6921<br>3 #12 >> PISH-6921 POWER | |
| L-69-026 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6926<br>TO: MCC-PEA VIA VFD-6926<br>3 #12 >> PISH-6926 POWER | |
| L-69-031 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6931<br>TO: MCC-PEA VIA VFD-6931<br>3 #12 >> PISH-6931 POWER | |
| L-69-036 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6936<br>TO: MCC-PEA VIA VFD-6936<br>3 #12 >> PISH-6936 POWER | |

# CONDUIT SCHEDULE AREA 69

## FILTER AND CHEMICAL FEED UPGRADES

## PEA DRY FEED AREA

| ENGINEER | CK |
|---|---|
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| L-69-041 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6941<br>TO: MCC-PEA VIA VFD-6941<br>3 #12 >> PISH-6941 POWER | |
| L-69-046 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6946<br>TO: MCC-PEA VIA VFD-6946<br>3 #12 >> PISH-6946 POWER | |
| L-69-051 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-6951<br>TO: MCC-PEA VIA VFD-6951<br>3 #12 >> PISH-6951 POWER | |
| L-69-056 | 69E03 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6956<br>TO: PNL-PEA<br>2 #12 >> PMP-6956 POWER | |
| L-69-061 | 69E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: MD-6961<br>TO: MCC-PEA<br>3 #12 >> MD-6961 POWER | |
| L-69-062 | 69E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: MD-6962<br>TO: MCC-PEA<br>3 #12 >> MD-6962 POWER | |
| L-69-161 | 69E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SUH-6961<br>TO: PNL-PEA<br>3 #12 >> SUH-6961 POWER | |
| L-69-162 | 69E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: SUH-6962<br>TO: PNL-PEA<br>3 #12 >> SUH-6962 POWER | |
| L-69-710 | 69E02 | 0.75" | 3 | #10 | XHHW-2 | 1 | #10 | XHHW-2 | FR: LCP-7100<br>TO: RTU-PEA<br>3 #10 >> LCP-7100 POWER | |
| L-69-903 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FV-6903<br>TO: VCP-6901<br>3 #12 >> FV-6903 POWER | |
| L-69-904 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FV-6904<br>TO: VCP-6901<br>3 #12 >> FV-6904 POWER | |
| L-69-907 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LSH-6907<br>TO: RTU-PEA<br>3 #12 >> LSH-6907 POWER | |
| L-69-913 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FV-6913<br>TO: VCP-6901<br>3 #12 >> FV-6913 POWER | |
| L-69-914 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: FV-6914<br>TO: VCP-6901<br>3 #12 >> FV-6914 POWER | |
| N-69-018 | 69E03 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6918<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6918 NETWORK | |
| N-69-019 | 69E03 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6919<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6919 NETWORK | |
| N-69-028 | 69E03 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6928<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6928 NETWORK | |
| N-69-029 | 69E03 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6929<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6929 NETWORK | |
| N-69-037 | 69E03 | 2" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6937<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6937 NETWORK | |
| N-69-038 | 69E03 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6938<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6938 NETWORK | |
| N-69-048 | 69E03 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6948<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6948 NETWORK | |

# CONDUIT SCHEDULE AREA 69

## FILTER AND CHEMICAL FEED UPGRADES

## PEA DRY FEED AREA

| | |
|---|---|
| ENGINEER | CK |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| N-69-049 | 69E03 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6949<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6949 NETWORK | |
| N-69-058 | | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6958<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6958 NETWORK | |
| N-69-611 | 69E04 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-69-621 | 69E04 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-69-631 | 69E04 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| N-69-641 | 69E04 | 1" | 1 | PULL | ROPE | | | | FR: SECURITY CAMERA J-BOX<br>TO: SECURITY PANEL<br>1 PULL >> SPARE | |
| P-69-001 | 69E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6901<br>TO: PP-PEA<br>3 #12 >> VCP-6901 POWER | |
| P-69-006 | 69E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: JB-6901<br>TO: DISC-6906<br>3 #12 >> HOI-6906 POWER | P-69-007 |
| P-69-007 | 69E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6906<br>TO: PP-PEA<br>3 #12 >> HOI-6906 POWER | P-69-006 |
| P-69-016 | 69E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: JB-6911<br>TO: DISC-6916<br>3 #12 >> HOI-6916 POWER | P-69-017 |
| P-69-017 | 69E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: DISC-6906<br>TO: PP-PEA<br>3 #12 >> HOI-6916 POWER | P-69-016 |
| P-69-021 | 69E03 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PMP-6921<br>TO: MCC-PEA VIA VFD-6921<br>1 3/C-#12:VFD >> PMP-6921 POWER | |
| P-69-026 | 69E03 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PMP-6926<br>TO: MCC-PEA VIA VFD-6926<br>1 3/C-#12:VFD >> PMP-6926 POWER | |
| P-69-031 | 69E03 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PMP-6931<br>TO: MCC-PEA VIA VFD-6931<br>1 3/C-#12:VFD >> PMP-6931 POWER | |
| P-69-036 | 69E03 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PMP-6936<br>TO: MCC-PEA VIA VFD-6936<br>1 3/C-#12:VFD >> PMP-6936 POWER | |
| P-69-041 | 69E03 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PMP-6941<br>TO: MCC-PEA VIA VFD-6941<br>1 3/C-#12:VFD >> PMP-6941 POWER | |
| P-69-046 | 69E03 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PMP-6946<br>TO: MCC-PEA VIA VFD-6946<br>1 3/C-#12:VFD >> PMP-6946 POWER | |
| P-69-051 | 69E03 | 1.5" | 1 | 3/C-#12:VFD | VFD | | | INTEGRAL | FR: PMP-6951<br>TO: MCC-PEA VIA VFD-6951<br>1 3/C-#12:VFD >> PMP-6951 POWER | |
| P-69-061 | 69E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: EF-6961<br>TO: MCC-PEA<br>3 #12 >> EF-6961 POWER | |
| P-69-062 | 69E05 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: EF-6962<br>TO: MCC-PEA<br>3 #12 >> EF-6962 POWER | |
| P-69-105 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: JB-6915<br>TO: VCP-6901<br>3 #12 >> MIX-6905 POWER | |

# CONDUIT SCHEDULE AREA 69

**FILTER AND CHEMICAL FEED UPGRADES**

**PEA DRY FEED AREA**

| | |
|---|---|
| **ENGINEER** | **CK** |
| **REVISION** | **0** |
| **DATE** | 2/11/25 |

| **CONDUIT** | | | **CONDUCTORS** | | | **GROUND** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **NUMBER** | **DWG** | **SIZE** | **#** | **SIZE** | **TYPE** | **#** | **SIZE** | **TYPE** | **DESCRIPTION** | **CONNECTING SEGMENTS** |
| P-69-115 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: JB-6915<br>TO: VCP-6901<br>3 #12 >> MIX-6915 POWER | |
| P-69-905 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: MIX-6905<br>TO: VCP-6901<br>3 #12 >> MIX-6905 POWER | |
| P-69-915 | 69E03 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: MIX-6915<br>TO: VCP-6901<br>3 #12 >> MIX-6915 POWER | |
| S-69-001 | 69E02 | 1" | 4 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6901<br>TO: RTU-PEA<br>1 2/CS-#16 >> PIT-6906 SIGNAL<br>1 2/CS-#16 >> PDIT-6905 SIGNAL<br>1 2/CS-#16 >> PIT-6914 SIGNAL<br>1 2/CS-#16 >> PDIT-6915 SIGNAL | |
| S-69-011 | 69E02 | 1" | 4 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: JB-6911<br>TO: VCP-6901<br>2 2/CS-#16 >> SPARE<br>2 2/CS-#16 >> PIT-6914 SIGNAL | |
| S-69-015 | | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: WIT-6915<br>TO: RTU-PEA<br>1 2/CS-#16 >> WIT-6915 SIGNAL | |
| S-69-101 | 69E02 | 1" | 4 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: JB-6901<br>TO: VCP-6901<br>2 2/CS-#16 >> SPARE<br>2 2/CS-#16 >> PIT-6906 SIGNAL | |
| S-69-105 | 69E03 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: JB-6905<br>TO: VCP-6901<br>2 2/CS-#16 >> SPARE | |
| S-69-115 | 69E03 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: JB-6915<br>TO: VCP-6901<br>2 2/CS-#16 >> SPARE | |
| S-69-505 | 69E03 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: WIT-6905<br>TO: RTU-PEA<br>1 2/CS-#16 >> WIT-6905 SIGNAL | |
| S-69-515 | 69E03 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: WIT-6915<br>TO: RTU-PEA<br>1 2/CS-#16 >> WIT-6915 SIGNAL | |
| S-69-606 | 69E03 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-6906<br>TO: VCP-6901<br>2 2/CS-#16 >> LIT-6901 SIGNAL | |
| S-69-710 | 69E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LCP-7100<br>TO: RTU-PEA<br>2 2/CS-#16 >> LCP-7100 SIGNAL | |

END OF CONDUIT SCHEDULE

END OF SECTION

## SECTION 16990K

## CONDUIT SCHEDULE
## AREA 71

## PART 1 GENERAL

### 1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. MFR: Manufacturer or vendor furnished cable.
   4. RS-485 RS-485 cable.

## PART 2 PRODUCTS

Not Used.

## PART 3 EXECUTION

### 3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

# CONDUIT SCHEDULE AREA 71

## FILTER AND CHEMICAL FEED UPGRADES

## PEC AREA

ENGINEER: CK
REVISION: 0
DATE: 2/11/25

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-71-001 | 71E01 | 0.75" | 6 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LCP-7100<br>TO: RTU-PEA<br>6 #14 >> LCP-7100 CONTROL | |
| C-71-002 | 71E02 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-7107<br>TO: RTU-PEA<br>10 #14 >> PMP-7107 CONTROL | |
| C-71-003 | 71E02 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-7106<br>TO: RTU-PEA<br>10 #14 >> PMP-7106 CONTROL | |
| C-71-004 | 71E01 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-7103<br>TO: RTU-PEA<br>8 #14 >> PMP-7103 CONTROL | |
| C-71-005 | 71E01 | 0.75" | 8 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PMP-7104<br>TO: RTU-PEA<br>8 #14 >> PMP-7104 CONTROL | |
| C-71-006 | 71E02 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-7104<br>TO: RTU-PEA<br>2 #14 >> LSH-7104 CONTROL<br>2 #14 >> LSH-710424 VDC POWER | |
| C-71-007 | 71E02 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: LE-7105<br>TO: LIT-7105<br>1 MFR >> LE-7105 CONTROL | |
| C-71-008 | 71E02 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: WE-7105<br>TO: WIT-7105<br>1 MFR >> WE-7105 CONTROL | |
| C-71-009 | 71E01 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FSH-7116<br>TO: RTU-PEA<br>2 #14 >> FSH-7116 CONTROL | |
| C-71-010 | 71E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: MCC-PEA<br>TO: RTU-PEA<br>2 #14 >> MCC-PEA CONTROL | |
| C-71-011 | 71E02 | 0.75" | 1 | MFR | CABLE | 1 | #14 | XHHW-2 | FR: WE-6211<br>TO: WIT-6211<br>1 MFR >> WE-6211 CONTROL | |
| C-71-103 | 71E01 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-7103<br>TO: RTU-PEA<br>2 #14 >> PISH-7103 CONTROL | |
| C-71-104 | 71E01 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-7104<br>TO: RTU-PEA<br>2 #14 >> PISH-7104 CONTROL | |
| C-71-106 | 71E02 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-7106<br>TO: RTU-PEA<br>2 #14 >> PISH-7106 CONTROL<br>2 #14 >> PISH-7106 24VDC POWER | |
| C-71-107 | 71E02 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-7107<br>TO: RTU-PEA<br>2 #14 >> PISH-7107 CONTROL<br>2 #14 >> PISH-7107 24VDC POWER | |
| C-71-108 | 71E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-7108<br>TO: RTU-PEA<br>2 #14 >> FIT-7108 24VDC CONTROL | |
| C-71-111 | 71E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: WIT-6211<br>TO: RTU-PEA<br>2 #14 >> WIT-6211 24VDC POWER | |
| C-71-113 | 71E01 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-7103<br>TO: FVNR-7103<br>2 #14 >> PISH-7103 CONTROL | |
| C-71-114 | 71E01 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: PISH-7104<br>TO: FVNR-7104<br>2 #14 >> PISH-7104 CONTROL | |
| C-71-203 | 71E01 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LE-7103<br>TO: RTU-PEA<br>2 #14 >> LE-7103 CONTROL | |

# CONDUIT SCHEDULE AREA 71

## FILTER AND CHEMICAL FEED UPGRADES

## PEC AREA

| | |
|---|---|
| ENGINEER | CK |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| C-71-204 | 71E02 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6204<br>TO: RTU-PEA<br>10 #14 >> PMP-6204 CONTROL | |
| C-71-205 | 71E02 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6205<br>TO: RTU-PEA<br>10 #14 >> PMP-6205 CONTROL | |
| C-71-211 | 71E02 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6211<br>TO: RTU-PEA<br>10 #14 >> PMP-6211 CONTROL | |
| C-71-214 | 71E02 | 0.75" | 4 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: LSH-6214<br>TO: RTU-PEA<br>2 #14 >> LSH-6214 CONTROL<br>2 #14 >> LSH-6214 24VDC POWER<br>214 | |
| C-71-215 | 71E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6215<br>TO: RTU-PEA<br>2 #14 >> FIT-6215 24VDC POWER | |
| C-71-216 | 71E02 | 0.75" | 2 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: FIT-6216<br>TO: RTU-PEA<br>2 #14 >> FIT-6216 24VDC POWER | |
| C-71-221 | 71E02 | 0.75" | 10 | #14 | XHHW-2 | 1 | #14 | XHHW-2 | FR: VCP-6221<br>TO: RTU-PEA<br>10 #14 >> PMP-6221 CONTROL | |
| L-71-001 | 71E01 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LCP-7100<br>TO: RTU-PEA<br>2 #12 >> LCP-7100 POWER | |
| L-71-002 | 71E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-7107<br>TO: PNL-PEA<br>2 #12 >> PMP-7107 POWER | |
| L-71-003 | 71E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-7106<br>TO: PNL-PEA<br>2 #12 >> PMP-7106 POWER | |
| L-71-004 | 71E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: RTU-PEA<br>TO: UPS-S<br>2 #12 12 RTU-PEA POWER | |
| L-71-005 | 71E02 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: RTU-PEA<br>TO: PNL-PEA<br>3 #12 >> RTU-PEA POWER | |
| L-71-103 | 71E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-7103<br>TO: FVNR-7103<br>3 #12 >> PISH-7103 POWER | |
| L-71-104 | 71E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PISH-7104<br>TO: FVNR-7104<br>3 #12 >> PISH-7104 POWER | |
| L-71-203 | 71E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: LE-7103<br>TO: RTU-PEA<br>3 #12 >> LE-7103 POWER | |
| L-71-204 | 71E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6204<br>TO: PNL-PEA<br>2 #12 >> PMP-6204 POWER | |
| L-71-205 | 71E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6205<br>TO: PNL-PEA<br>2 #12 >> PMP-6205 POWER | |
| L-71-211 | 71E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6211<br>TO: PNL-PEA<br>2 #12 >> PMP-6211 POWER | |
| L-71-221 | 71E02 | 0.75" | 2 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: VCP-6221<br>TO: PNL-PEA<br>2 #12 >> PMP-6221 POWER | |
| N-71-001 | 71E02 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: MCC-PEA<br>TO: RTU-PEA<br>1 RS-485 >> MCC-PEA NETWORK | |

# CONDUIT SCHEDULE AREA 71

## FILTER AND CHEMICAL FEED UPGRADES

## PEC AREA

| | |
|---|---|
| ENGINEER | CK |
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| N-71-108 | 71E02 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-7108<br>TO: RTU-PEA<br>1 RS-485 >> FIT-7108 NETWORK | |
| N-71-215 | 71E02 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6215<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6215 NETWORK | |
| N-71-216 | 71E02 | 0.75" | 1 | | RS-485 | 1 | #14 | XHHW-2 | FR: FIT-6216<br>TO: RTU-PEA<br>1 RS-485 >> FIT-6216 NETWORK | |
| P-71-001 | 71E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-7103<br>TO: MCC-PEA VIA FVNR-7103<br>3 #12 >> PMP-7103 POWER | |
| P-71-002 | 71E01 | 0.75" | 3 | #12 | XHHW-2 | 1 | #12 | XHHW-2 | FR: PMP-7104<br>TO: MCC-PEA VIA FVNR-7104<br>3 #12 >> PMP-7104 POWER | |
| P-71-003 | 71E02 | 1.5" | 3 | #2 | XHHW-2 | 1 | #8 | XHHW-2 | FR: PP-PEA<br>TO: MCC-PEA<br>3 #2 >> PP-PEA POWER | |
| P-71-004 | 71E02 | 1.5" | 3 | #1/0 | XHHW-2 | 1 | #6 | XHHW-2 | FR: PNL-PEA<br>TO: XFMR-PEA<br>3 #1/0 >> PNL-PEA POWER | |
| P-71-006 | 71E02 | 1.5" | 3 | #1/0 | XHHW-2 | 1 | #6 | XHHW-2 | FR: XFMR-PEA<br>TO: MCC-PEA<br>3 #1/0 >> XFMR-PEA POWER | |
| P-71-007 | 71E02 | 2" | 3 | #4/0 | XHHW-2 | 1 | #4 | XHHW-2 | FR: MCC-PEA<br>TO: MCC-B1<br>3 #4/0 >> MCC-PEA POWER | |
| S-71-001 | 71E01 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-7101<br>TO: RTU-PEA<br>1 2/CS-#16 >> LIT-7101 SIGNAL | |
| S-71-002 | 71E01 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-7102<br>TO: RTU-PEA<br>1 2/CS-#16 >> LIT-7102 SIGNAL | |
| S-71-003 | 71E01 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LCP-7100<br>TO: RTU-PEA<br>2 2/CS-#16 >> LCP-7100 SIGNAL | |
| S-71-004 | 71E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-7107<br>TO: RTU-PEA<br>2 2/CS-#16 >> PMP-7107 SIGNAL | |
| S-71-005 | 71E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-7106<br>TO: RTU-PEA<br>2 2/CS-#16 >> PMP-7106 SIGNAL | |
| S-71-006 | 71E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-7105<br>TO: RTU-PEA<br>1 2/CS-#16 >> LIT-7105 SIGNAL | |
| S-71-007 | 71E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: WIT-7105<br>TO: RTU-PEA<br>1 2/CS-#16 >> WIT-7105 SIGNAL | |
| S-71-011 | 71E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: LIT-6211<br>TO: RTU-PEA<br>1 2/CS-#16 >> LIT-6211 SIGNAL | |
| S-71-111 | 71E02 | 0.75" | 1 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: WIT-6211<br>TO: RTU-PEA<br>1 2/CS-#16 >> WIT-6211 SIGNAL | |
| S-71-204 | 71E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6204<br>TO: RTU-PEA<br>2 2/CS-#16 >> PMP-6204 SIGNAL | |
| S-71-205 | 71E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6205<br>TO: RTU-PEA<br>2 2/CS-#16 >> PMP-6205 SIGNAL | |
| S-71-211 | 71E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6211<br>TO: RTU-PEA<br>2 2/CS-#16 >> PMP-6211 SIGNAL | |

# CONDUIT SCHEDULE AREA 71

**FILTER AND CHEMICAL FEED UPGRADES**

**PEC AREA**

| ENGINEER | CK |
|---|---|
| REVISION | 0 |
| DATE | 2/11/25 |

| CONDUIT | | | CONDUCTORS | | | GROUND | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NUMBER | DWG | SIZE | # | SIZE | TYPE | # | SIZE | TYPE | DESCRIPTION | CONNECTING SEGMENTS |
| S-71-221 | 71E02 | 0.75" | 2 | 2/CS-#16 | | 1 | #14 | XHHW-2 | FR: VCP-6221<br>TO: RTU-PEA<br>2 2/CS-#16 >> PMP-6221 SIGNAL | |
| | | | | | | | | | | |

END OF CONDUIT SCHEDULE

END OF SECTION