

SECTION 11220

SUBMERSIBLE MIXER

PART 1 GENERAL

1.1 SUMMARY

- A. This section covers submersible mixers.

1.2 REFERENCES

- A. Comply with the applicable reference specifications as specified in the General Requirements
- B. Occupational Safety and Health Administration, OSHA
- C. NSF/ ANSI Standard 61
- D. Underwriters Laboratories Inc., UL 508

1.3 REQUIREMENTS

- A. CONTRACTOR shall furnish and install submersible mixing system together with controls and accessories necessary for a complete and operable system.
- B. Each mixer shall have the ability to function continuously on a year-round basis, regardless of drain and fill cycles. Each mixer shall consist of a water-filled submersible motor, an impeller and a non-submersible control center that houses all control electronics. The mixer shall be suitable for continuous use while submerged in potable water storage tanks.

1.4 CONTRACTOR SUBMITTALS

- A. NSF Certification
 - 1. Copies of the NSF-61 certified listing for all submersible mixer material being placed inside the tank and headspace, including the motor and power cable.
- B. Installation, Operations, and Maintenance Manuals shall be obtained from the equipment manufacturer and submitted. The following sections shall be included:
 - 1. General equipment specifications and data sheets.
 - 2. Installation, start-up, operation, and maintenance instructions.
 - 3. Factory-recommended maintenance schedule.
 - 4. Wiring diagrams specifying what electrical wiring needs to be done onsite during and prior to the installation, and by which responsible party.
 - 5. List of equipment or tooling necessary for diagnostics, trouble-shooting, repair or general maintenance.

1.5 QUALITY ASSURANCE

- A. Each mixing system shall be tested prior to deployment according to standard engineering practices at the factory testing facilities.
- B. Complete mixing system is NSF/ANSI Standard 61 certified by NSF.

1.6 WARRANTY

- A. Beginning with shipment to Buyer and ending on the time periods listed below, the Product is warranted to be substantially free from defects in material and workmanship and to conform to Seller's specifications applicable to the Product –
 - 1. Three (3) years on all supplied parts.
 - 2. One hundred twenty (120) days labor.

PART 2 PRODUCTS

2.1 SUBMERSIBLE MIXER - SMALL

A. PERFORMANCE

- 1. Mixing system shall completely mix reservoir according to the following minimum performance requirements. These requirements shall be measured and validated after installation by operators with the help of mixer manufacturer with readily-available tools such as temperature probes and total chlorine grab samplers.
 - a. Temperature Uniformity
 - 1) For tanks up to 375,000 gallons in volume: All temperatures shall converge to within 0.50°C within 24 hours after mixer is installed and activated.
 - 2) Disinfectant Residual Uniformity
 - 3) For tanks up to 375,000 gallons in volume: Disinfectant residual within top five feet of tank and bottom five feet of tank will converge to within 0.20 ppm within 24 hours after mixer is installed and activated. During continuous operation of the mixer, disinfectant residual will converge to within 0.20 ppm at least once every 24 hours.

B. GENERAL

- 1. Mixing system consists of a spiral-shaped nozzle mounted in a submersible stainless steel casing. System is lowered to the tank floor and creates a vertical flow pattern inside the tank. Devices with an externally mounted pump shall not be acceptable. Mixer operation shall be independent of tank drain and fill cycles to ensure constant mixing. Mixer shall weigh less than 40 lbs (~18 kg) and be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.

2. Mixing system inlet shall be elevated at a minimum of 6” above tank floor to avoid disturbing accumulated tank sediment or entraining particles and causing accelerated wear of moving parts.
3. Mixers using submersible pump with slit or “water sheet” or horizontal motor mounting designs are not acceptable.
4. Mixers shall include a buoyancy mechanism to keep nozzle pointing upright no matter the angle of the tank floor.
5. Mixers shall include integrated power cable as a lowering mechanism for simplicity.
6. Mixer provider must have more than 1000 installation of similar equipment in potable water tank.
7. Mixers shall have no oil-filled parts.
8. All wet-side mixer components shall be certified by NSF to the NSF/ANSI Standard 61
9. Dry-side mixer components shall include sine filter to prolong motor life and reduce noise level.
10. Power source for mixer shall be 115VAC single phase grid power to allow unit to continue 24/7 operation.
11. No maintenance required on the wet-side components in typical potable water application.
12. No passive mixing system allowed.

C. CONSTRUCTION

1. The mixer shall be certified by NSF to the NSF/ANSI Standard 61.
2. Equipment entering tank shall not adhere to, scratch or otherwise cause damage to internal tank coating or put undue stress on the materials of the tank construction. Equipment shall fit through a standard hatch of size 12” x12” or larger. UTILITY may prefer to puncture side-wall or ceiling of tank (in place of penetrating the hatch-way) to allow motor cable entry into the tank and protection against freezing/ice damage.
3. Each submersible mixer shall consist of the following components, regardless of the power source selected:
 - a. Nozzle
 - 1) AISI Type 316 Stainless Steel
 - 2) Electropolished to minimize surface corrosion
 - b. Nozzle housing
 - 1) AISI Type 316 Stainless Steel
 - 2) Brush finish to minimize surface corrosion
 - 3) Buoyancy mechanism to keep nozzle pointing upright no matter the angle of the tank floor
 - 4) Chlorine/chloramine resistant rubber foot pad to avoid scratching tank floor
 - 5) Integrated power cable and lowering mechanism for simplicity
 - c. Motor
 - 1) Stainless Steel 304 body
 - 2) Chlorine/Chloramine resistant rubber seals
 - 3) Fully submersible

4. Control Center shall include the following:
 - a. On/Off Safety Disconnect Switch with indicator light and SCADA Interface.
 - b. Enclosure
 - 1) Type 3R
 - 2) Lockable
 - 3) Weather Resistant
 - 4) Indicator light showing Mixer run status
 - 5) Manual On/Off Switch
 - 6) SCADA Interface: Digital output indicating motor running (Output contacts are SPDT, UL/CUR File E44211 Approved Contact Ratings)
 - c. The SCADA interface shall include SPDT dry contacts for hardwired alarms. The alarms shall include:
 - 1) Mixer running monitoring
 - 2) Mixer fault monitoring
 - 3) ON/OFF remote control
 - d. GFCI-protection
 - 1) 115/230VAC, single-phase, with a 300mA trip level GFCI included inside control center
 - e. Branch Circuit Protection
 - 1) Panel equipped with a 115/230VAC 20-Amp main breaker
 - f. Sine Filter

D. CONTROLS

1. Each unit shall be equipped with all necessary controls, inter-wired, to provide the following minimum functions:
 - a. On/Off switch to control power to mixer.
 - b. Automatically-activated motor shut-off if water level drops below motor height in tank.
 - c. Sine filter
 - d. Any other controls shown on electrical and instrumentation drawings

E. MANUFACTURER

1. PAX Water Technologies PWM100 PAX Mixer with a PCC105 PAX Control Center.

2.2 SUBMERSIBLE MIXER - LARGE

A. PERFORMANCE

1. Mixing system shall completely mix reservoir according to the following minimum performance requirements. These requirements shall be measured and validated after installation by operators with the help of mixer manufacturer with readily-available tools such as temperature probes and total chlorine grab samplers.
 - a. Temperature Uniformity
 - 1) For tanks up to 750,000 gallons in volume: All temperatures shall converge to within 0.50°C within 24 hours after mixer is installed and activated.
 - 2) Disinfectant Residual Uniformity

- 3) For tanks up to 750,000 gallons in volume: Disinfectant residual within top five feet of tank and bottom five feet of tank will converge to within 0.20 ppm within 24 hours after mixer is installed and activated. During continuous operation of the mixer, disinfectant residual will converge to within 0.20 ppm at least once every 24 hours.

B. GENERAL

1. Mixing system consists of a spiral-shaped nozzle mounted in a submersible stainless steel casing. System is lowered to the tank floor and creates a vertical flow pattern inside the tank. Devices with an externally mounted pump shall not be acceptable. Mixer operation shall be independent of tank drain and fill cycles to ensure constant mixing. Mixer shall weigh less than 45 lbs (~18 kg) and be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.
2. Mixing system inlet shall be elevated at a minimum of 6" above tank floor to avoid disturbing accumulated tank sediment or entraining particles and causing accelerated wear of moving parts.
3. Mixers using submersible pump with slit or "water sheet" or horizontal motor mounting designs are not acceptable.
4. Mixers shall include a buoyancy mechanism to keep nozzle pointing upright no matter the angle of the tank floor.
5. Mixers shall include integrated power cable as a lowering mechanism for simplicity.
6. Mixer provider must have more than 1000 installation of similar equipment in potable water tank.
7. Mixers shall have no oil-filled parts.
8. All wet-side mixer components shall be certified by NSF to the NSF/ANSI Standard 61
9. Dry-side mixer components shall include sine filter to prolong motor life and reduce noise level.
10. Power source for mixer shall be 115VAC single phase grid power to allow unit to continue 24/7 operation.
11. No maintenance required on the wet-side components in typical potable water application.
12. No passive mixing system allowed.

C. CONSTRUCTION

1. The mixer shall be certified by NSF to the NSF/ANSI Standard 61.
2. Equipment entering tank shall not adhere to, scratch or otherwise cause damage to internal tank coating or put undue stress on the materials of the tank construction. Equipment shall fit through a standard hatch of size 18" x18" or larger. UTILITY may prefer to puncture side-wall or ceiling of tank (in place of penetrating the hatch-way) to allow motor cable entry into the tank and protection against freezing/ice damage.

3. Each submersible mixer shall consist of the following components, regardless of the power source selected:
 - a. Nozzle
 - 1) AISI Type 316 Stainless Steel
 - 2) Electropolished to minimize surface corrosion
 - b. Nozzle housing
 - 1) AISI Type 316 Stainless Steel
 - 2) Brush finish to minimize surface corrosion
 - 3) Buoyancy mechanism to keep nozzle pointing upright no matter the angle of the tank floor
 - 4) Chlorine/chloramine resistant rubber foot pad to avoid scratching tank floor
 - 5) Integrated power cable and lowering mechanism for simplicity
 - c. Motor
 - 1) Stainless Steel 304 body
 - 2) Chlorine/Chloramine resistant rubber seals
 - 3) Fully submersible
4. Control Center shall include the following:
 - a. On/Off Safety Disconnect Switch with indicator light and SCADA Interface.
 - b. Enclosure
 - 1) Type 3R
 - 2) Lockable
 - 3) Weather Resistant
 - 4) Indicator light showing Mixer run status
 - 5) Manual On/Off Switch
 - 6) SCADA Interface: Digital output indicating motor running (Output contacts are SPDT, UL/CUR File E44211 Approved Contact Ratings)
 - c. The SCADA interface shall include SPDT dry contacts for hardwired alarms. The alarms shall include:
 - 1) Mixer running monitoring
 - 2) Mixer fault monitoring
 - 3) ON/OFF remote control
 - d. GFCI-protection
 - 1) 115/230VAC, single-phase, with a 300mA trip level GFCI included inside control center
 - e. Branch Circuit Protection
 - 1) Panel equipped with a 115/230VAC 20-Amp main breaker
 - f. Sine Filter

D. CONTROLS

1. Each unit shall be equipped with all necessary controls, inter-wired, to provide the following minimum functions:
 - a. On/Off switch to control power to mixer.
 - b. Automatically-activated motor shut-off if water level drops below motor height in tank.
 - c. Sine filter
 - d. Any other controls shown on electrical and instrumentation drawings

E. MANUFACTURER

1. PAX Water Technologies PWM150 PAX Mixer with a PCC155 PAX Control Center.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The CONTRACTOR shall furnish services of a factory-trained and certified installation contractor or crew having experience with installation procedures and operation and maintenance requirements for the type of equipment installed under these specifications. Mixer must be able to be installed through a 12"x12" hatch for small mixer and 18"x18" hatch for large mixer. Mixer must be able to be installed without draining tank or taking tank out of service. Wet-side of Mixer shall weigh less than 45 pounds (~18 kg) and dry-side shall weigh less than 55 pounds (~25 kg). Both wet-side and dry-side shall be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that weight of mixer on tank floor does not cause damage to interior coating.
- B. The mixer and optional SCADA interface or control center shall be installed in accordance with approved procedures submitted and as shown, unless otherwise approved in writing from the Factory.

3.2 START-UP AND COMMISSIONING

- A. A factory-trained and certified individual shall provide start-up and commissioning.
- B. After installation and connection work has been completed, CONTRACTOR shall verify the equipment is properly installed.
 1. CONTRACTOR to verify the following
 2. Polarity of electric power and signal connections.
 3. Correct applied voltages to all equipment.
 4. Required grounds are properly connected.
 5. The integrity of all connections.
- C. CONTRACTOR shall certify in writing that the system has been verified for proper installation.
- D. System Testing
 1. The CONTRACTOR shall notify the ENGINEER a minimum of 14 days in advance of the scheduled system testing.
 2. System testing shall not commence until after approved acceptance of all wire, calibration, and loop tests.
 3. All systems shall be tested prior to the beginning of plant operational testing.
 4. Completion of system testing activities shall be documented by a certified report, including all test forms, with test data entered, furnished to ENGINEER.

5. System testing shall at a minimum demonstrate the following:
 - a. Each component of the system operates properly with all other components of the system.
 - b. Interlocks perform properly.
 - c. Control sequences perform properly.
 6. System testing activities shall include the use of water to establish service conditions simulating normal final control element operating conditions in terms of applied process loads, operating ranges and environmental conditions.
 7. Final control elements, control panels and supplementary equipment shall be tested under start up and steady state operating conditions to verify proper and stable control is achieved using all control center and field mounted control circuits associated with each system.
 8. Hardwired and software control circuit interlocks and alarms shall be operational.
 9. Control of final control elements and supplementary equipment shall be tested using both manual and automatic control circuits.
 10. Stable steady state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers, to eliminate oscillatory final control element operation.
 11. CONTRACTOR shall submit to ENGINEER a copy of completed test reports specified in this Section and Section 16080 - Electrical Testing
- E. Commissioning
1. CONTRACTOR shall then perform Commissioning as follows:
 - a. Operating the station for 7 consecutive days without a significant interruption with the exception of any interruption caused by training conducted during this time period.
 - b. The station shall be operated in every designed control mode including the operation of all equipment.
 2. Should a significant interruption occur the fault causing the interruption shall be corrected by the CONTRACTOR and the Commissioning period of 7 consecutive days shall be restarted

3.3 TRAINING

- A. PAX Water Technologies staff (or their representatives) will instruct designated UTILITY personnel in the safe and proper operation of the PAX Water Mixer. This training will reference the operations manual provided with equipment, and show how to check for proper functioning of the equipment.
- B. Reference Section 16015 Demonstration & Training for additional requirements.

END OF SECTION

SECTION 13410

BASIC MEASUREMENT AND CONTROL INSTRUMENTATION MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes.

1. This Section contains the basic materials and methods required to install the measurement and control instrumentation system.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 13 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 13410.F30) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data.

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, equipment weight, and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Insulated Wire Ferrules (13410.F30).**

1. Ferrules shall be plastic sleeved and insulated.
2. Ferrules shall be color coded per the DIN Standard.
3. Provide Weidmuller ferrules, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. CONTRACTOR shall install and connect junction boxes, termination boxes, control panels, field devices, etc. as shown on the Drawings.
- B. Conductor Terminations.
 - 1. Provide ferrules on all conductors terminating on terminal strips.
 - 2. Ferrules shall be installed with a tool supplied by the ferrule manufacturer design specifically for that purpose.
 - 3. No more than one conductor shall be terminated on each side of a terminal block unless specifically shown otherwise on the Drawings.
- C. Terminal Block Jumpers.
 - 1. When connecting adjacent terminal blocks in a terminal strip to provide for common potentials, pre-manufactured bridge type jumpers supplied by the terminal manufacturer shall be used. These jumpers screw into and connect adjacent terminal blocks at the center of the terminal blocks.
 - 2. Comb type jumper shall not be used.
 - 3. Jumpers fabricated from short lengths of wire shall not be used.
- D. Equipment Grounding.
 - 1. Each control panel, terminal box and junction box shall have a single grounding point consisting of a grounding bus bar. All grounding conductors terminating within the enclosure shall terminate on the ground bus. The ground bus bar shall be 100 percent copper with 10 percent spare opening for future use. Reference Section 16060 Grounding And Bonding for specification requirements for grounding bus bar.
- E. Conductor Splicing.
 - 1. Conductors shall be spliced on terminal blocks installed for this purpose.
 - a. Conductors shall only be spliced where identified on the Drawings.
 - 2. No other splicing methods shall be approved without prior approval by the ENGINEER.
- F. Terminal Block and Terminal Strip Identification.
 - 1. Terminal blocks shall be identified as shown on the Drawings. Identification shall be provided on both sides of the terminal block. The plastic identification inserts shall be machine printed and provided by the manufacturer of the terminal blocks.
 - 2. Terminal strips shall be identified as shown on the drawings.
- G. Identification
 - 1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.

3.2 FIELD QUALITY CONTROL

A. Site Tests.

1. Control and instrumentation related conductors shall be tested for resistance to ground through the use of an ohm meter and visual damage to the insulation. Grounded conductors (neutrals and negative conductors) shall be isolated from the grounding system before testing.
2. High voltage “meggers” shall not be used.
3. A conductor shall be replaced if the resistance reading is less than one meg-ohm.
4. CONTRACTOR shall record the results of these tests on the Continuity Test Certification forms and submit them to the ENGINEER as specified in Section 16080 Electrical Testing.

END OF SECTION

SECTION 13430

BOXES, CONTROL PANELS, AND CONTROL CENTERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. This section contains the requirements pertaining to the construction and installation of the control panels.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 13 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 13430.H17) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.

C. Shop Drawings

1. Dimensional drawings showing the overall length, width, and height of the assembled control panel. Included on these drawings shall be the back panel layout of installed control devices showing part numbers, dimensions, nameplate text, and other details required for a complete assembly. The CONTRACTOR shall obtain the Drawings for the control panel layout and schematic from the ENGINEER. The CONTRACTOR shall modify the Drawings as required for submittal and for as-built documentation. The CONTRACTOR shall not generate their own drawings.
2. For large control panel, physical properties, handling, mounting, shipping break point locations shall be shown in submittal drawings. This shall include total weight, lifting instructions, height, and floor space required.

3. Provide electrical schematic drawings that include: wiring details such as internal and field connection terminal block numbers; shielded wire termination requirements; grounding requirements; and wire colors. Show all required internal and external interlocking. Each drawing shall be circuit specific for the system submitted. No typical schematic drawings shall be submitted.
4. Drawings shall list the equipment number of the box, control panel, or center submitted.
5. Component designations shall match those shown on the Drawings.
6. Complete bills of materials shall be included with submittal.

1.3 QUALITY ASSURANCE

A. Qualifications

1. Equipment provided as part of this section shall be manufactured by a single licensed firm, regularly engaged in the design and manufacture of such equipment for a minimum of five years. The control panels shall have a UL508A listing. Components within control panels shall be listed in a manner consistent with UL508A requirements.

1.4 MAINTENANCE

A. Manufacturer shall provide and list in the bill of materials the following spare parts.

1. One each of all power and control fuses provided in the assembled control panel/center.

B. Provide Operation and Maintenance Data and Manuals Pursuant to the Contract Documents.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Enclosures (13430.E00).

1. Enclosures shall be provided as shown on the Drawings.
2. Enclosures shall be provided with accessories as shown on the Drawings and as specified below.
3. Enclosures in damp, wet, corrosive, or outdoor locations shall be: constructed of fiberglass (NEMA 4X) with zinc electroplated (galvanized) steel back-panel; continuous hinged with gasketed doors and screw down clamps.
4. Enclosures in outdoor locations shall be equipped with a hasp and staple for padlocking.

B. Mixer Termination Enclosures (13430.E02).

1. Enclosures shall be provided as shown on the Drawings.
2. Enclosures shall be provided with accessories as shown on the Drawings and as specified below.

3. Enclosures shall be constructed of fiberglass (NEMA 4X) with zinc electroplated (galvanized) steel back-panel; continuous hinged with gasketed doors and screw down clamps.
4. Enclosures shall be equipped with a hasp and staple for padlocking.
5. Provide Hoffman Enclosure, or approved equal.

C. Low Current Terminal Blocks (13430.T10).

1. Low current terminal blocks shall be provided as shown on the Drawings and in all panels requiring low current field terminations. Provide accessories as required and as shown including, but not limited to end anchors, end barriers, bridge jumpers, terminal strip pre-printed markers and snap-in pre-printed terminal block markers.
2. Low current terminal blocks shall be used for electrical circuits rated at or less than 30 amps.
3. Low current terminal blocks shall mount on DIN rail.
4. Low current terminal blocks shall be supplied with all required accessories including end covers, fixed bridge bars, partition plates and end brackets.
5. Low current terminal blocks shall be supplied with machine printed terminal block and terminal strip identification numbers that match the approved submittals.
6. Low current terminal blocks shall be grey in color.
7. Low current terminal blocks shall be UL rated for up to 30 amps at 600 VAC.
8. Low current terminal blocks shall accept wires from 24 to 10 AWG for single conductor per termination.
9. Provide Phoenix Contact model UK5N, or approved equal.

D. Grounding Terminal Blocks (13430.T60).

1. Grounding terminal blocks shall be provided as shown on the Drawings and in all panels requiring field terminations.
2. Grounding terminal blocks shall be used for electrical circuits rated at or less than 30 amps.
3. Grounding terminal blocks shall mount on DIN rail.
4. Grounding terminal blocks shall be UL rated for a maximum of 30 amps and 600 VAC and to accept wires from 26 to 10 AWG for single conductor per termination.
5. Grounding terminal blocks shall be supplied with all required accessories including end covers, fixed bridge bars, partition plates and end brackets.
6. Low current terminal blocks shall be supplied with machine printed terminal block and terminal strip identification numbers that match the approved submittals.
7. Grounding terminal blocks shall be green / yellow in color.
8. Provide Phoenix Contact model USLKG5, or approved equal.

E. Insulated Wire Ferrules (13430.F30).

1. Insulated wire ferrules shall be provided for all wiring within boxes, control panels, and control centers.
2. Insulated wire ferrules shall be plastic sleeved and insulated.
3. Insulated wire ferrule color code shall match DIN color code.
4. Insulated wire ferrules shall be installed using a controlled cycle tool from the ferrule manufacturer and specifically intended for use with the ferrules provided.
5. Provide Panduit, Thomas & Betts, or approved equal.

F. Wire Identification Labels (13430.L02).

1. Wire identification labels shall be provided for all conductors within control panels and control centers.
2. Wire identification labels shall be machine printed, non-adhesive, wire marker heat shrink sleeves with identification numbers that match the approved submittals.
3. Wire identification labels shall be properly sized for the conductor or cable and shall be white with black characters.
4. Provide Brady, Panduit, or approved equal.

G. Cable Ties (13430.W40).

1. Cable Ties shall be provided as required for organizing and arranging conductors within boxes, control panels, and control centers.
2. Cable ties shall be UV resistant.
3. Cable ties shall be black in color.
4. Cable ties shall be installed using a tool from the cable tie manufacturer and specifically intended for use with the cable ties provided.
5. Provide Panduit, Thomas & Betts, or approved equal.

H. DIN Mounting Rail (13430.D10).

1. DIN Mounting Rail shall be provided as shown on the Drawings and in all panels requiring DIN mounting rail.
2. DIN mounting rails shall be made of steel, galvanized, and yellow chromated.
3. Provide Allen-Bradley model 199-DR1, or approved equal.

I. Ground Bars (13430.G06).

1. Ground bars shall be provided as shown on the Drawings.
2. Ground bars shall be low profile, "bus" type with set screw or pressure type connections and all copper construction.
3. Ground bars shall include sufficient termination points to accommodate all equipment grounding conductors as shown on the Drawings.
4. Ground bars shall include spare termination points to accommodate twenty (20) additional conductors sized, #14 through #8 AWG.
5. Provide Cutler-Hammer model GBK21, GE model TGK42, Square D model PK27GTA, or approved equal.

J. Heavy Duty End Bracket (13430.A61).

1. Provide heavy duty end brackets on DIN rails as indicated on the Drawings.
2. Heavy duty end brackets shall be suitable for 35 mm DIN rails.
3. End brackets shall be screw-on style.
4. Provide Phoenix E/AL-NS 35 series or approved equal.

PART 3 EXECUTION

3.1 INSTALLERS

- A. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.

- B. CONTRACTOR shall install and connect junction boxes and control panels and field devices as shown on the Drawings.
- C. For all conductors terminating on terminal strips, install crimp-on, insulated plastic sleeve ferrules on each wire. Install ferrules with a crimping tool provided by the ferrule manufacturer for that purpose.
- D. Individual conductors and cables shall be grouped together and routed through plastic wire ducts mounted on the backpanel surface.
- E. Bond each enclosure back-panel to the grounding electrode system with a # 8 AWG copper conductor.
- F. Where conductors and cables are routed in boxes or enclosures, they shall be neatly bundled with cable ties at intervals not to exceed 12 inches on center. The tension for the cable ties shall be set with a tool specifically made for this purpose and of the same manufacturer as the cable tie. Side cutters or other type tools shall not be used to cut the tail end of the cable tie. The CONTRACTOR shall only use the tool specifically made for this purpose and designed for use with the cable ties provided.

3.2 SOURCE QUALITY CONTROL

A. Tests and Inspections

1. CONTRACTOR shall notify the ENGINEER 14 days prior to commencement of shop testing. All equipment shall be tested prior to site delivery.
2. CONTRACTOR-developed test forms shall accompany the notification of testing.
 - a. Test forms shall list all field connections at terminal strips and all internal logic circuits, along with the method planned for simulation of field conditions to test these connections and circuits.
3. All analog instrument loops shall be tested using an analog signal generator by applying the appropriate control signal to the field termination terminal strip.
 - a. At a minimum, analog instrument tests shall be made at 0%, 25%, 50%, 75%, and 100% of maximum control signal.
 - b. Additional analog instrument tests shall be made as appropriate.
4. All digital control circuits shall be tested by: applying the appropriate control voltage to the field termination terminal strip when externally supplied; using a jumper at the field termination terminal strip when internally supplied; or, if applicable, at an internal panel connection point when field terminations are not used.

B. Verification of Performance

1. Device functions shall be observed by the ENGINEER, to determine satisfactory operation of the device and connected circuit continuity, prior to shipment.

3.3 FIELD QUALITY CONTROL

A. Site Tests, Inspection

1. CONTRACTOR shall install, calibrate and test, all systems prior to notifying ENGINEER of witness testing verification.

END OF SECTION

SECTION 16000
GENERAL PROVISIONS

PART 1 GENERAL

1.1 PERMITS, FEES AND SERVICE CHARGES

- A. The CONTRACTOR shall obtain all electrical permits required to complete the work and pay all associated fees.

1.2 FIELD VERIFICATION DURING THE BIDDING PROCESS

- A. The CONTRACTOR shall be responsible for performing field verification of the existing conditions prior to bidding. The nature of this work inherently requires field observation to understand the existing conditions and scope of work.
- B. Failure to observe the existing conditions or ignorance of existing conditions shall the responsibility of the CONTRACTOR alone. Additional services shall not be authorized due to the CONTRACTOR'S lack of understanding of the existing conditions.

1.3 INTENT OF DRAWINGS AND SPECIFICATIONS

- A. Riser and other diagrams are schematic and are intended to show the approximate location of equipment, and the general alignment of conduits and piping, and shall not be used for obtaining quantities. Dimensions given on the plans shall take precedence over scaled dimensions and all dimensions whether in figures or scaled, shall be verified in the field.
- B. The electrical drawings do not show complete details of the site conditions. The CONTRACTOR shall check actual conditions.
- C. The exact location of apparatus, fixtures, equipment, conduit and piping shall be ascertained by the CONTRACTOR in the field, and the work shall be laid out accordingly. Should the CONTRACTOR fail to ascertain such locations or coordinate with work performed by other trades, the work shall be changed at no additional cost to the OWNER when so ordered by the ENGINEER. The ENGINEER reserves the right to make minor changes in the location of conduit, piping and equipment up to the time of installation without additional cost to OWNER.
- D. CONTRACTOR shall provide all labor, materials, equipment, machinery, and tools necessary to provide all electrical equipment specified and shown on the Drawings. All items not specified in detail or shown on the Drawings but necessary for complete installation shall be provided by the CONTRACTOR.

1.4 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16000.A01) typewritten in the upper right hand corner of the submittal.
 3. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 4. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
- B. Submittals shall be in accordance with the requirements of these Contract Documents and shall include the following:
1. Submittals shall include information and literature as required for all equipment and materials provided under this and related sections.
 2. Shop Drawings: Shop drawings shall include the following along with any special requirements listed in the individual Specification Sections:
 - a. Installation instructions and drawings
 - b. Wiring schematics with termination point identification
 - c. Motor information
 - d. Materials of construction
 - e. Manufacturer's name and model
 - f. Manufacturer's catalog data
 - g. Supplementary structural framing for electrical equipment including design loads, member size and location. When supplementary framing is indicated, verify that dimensions are suitable for the equipment furnished. Provide additional strength when equipment furnished is heavier than that specified.
 3. Manufacturers' Literature: Literature indicating the compliance of the products with the Specifications shall be included with all submittals. This shall include catalogs and other descriptive bulletins. Relevant portions of the literature shall be clearly identified by highlighting or underlining.
 4. Test Logs: The CONTRACTOR shall submit test logs as outlined below and as specified in subsequent electrical sections and drawings.
 - a. A log of the complete results of tests for shorts and grounds for each circuit. All circuits and tests shall be clearly identified.
 - b. A log of complete results of insulation resistance measurements of each circuit. All circuits and tests shall be clearly identified.
 5. Operation and maintenance information for all equipment furnished and/or installed.

6. Programming instructions for any controllers or other programmable equipment. Copies of the any required software, including registration cards, shall be provided with the O&M manuals.
- C. The CONTRACTOR shall indicate on the submittals all variances from the Specifications.
- D. Record Drawings. After the completion of construction, the CONTRACTOR shall provide one set of “as-built” drawings to the ENGINEER as specified herein showing the location of buried conduits and all changes or deviations from the original drawings.
- E. After the completion of construction, a printout and electronic copy of any programming and/or set-points for controllers, PLCs, meters or other programmable equipment including VFDs.
- F. Final inspection certificates shall be submitted prior to final payment.

1.5 COORDINATION OF WORK

- A. The CONTRACTOR shall plan his work in coordination with the other trades and with the power and telephone utility authorities.
- B. The CONTRACTOR shall field verify all dimensions of equipment to be installed or provided by others so that correct clearances and connections may be made between the work installed by the CONTRACTOR and equipment installed or provided by others.
- C. The CONTRACTOR shall arrange all conduit runs so that they do not interfere with piping, structural members, etc.
- D. All working measurements shall be taken from the sites, checked with those shown on the drawings, and if they conflict, reported to the ENGINEER at once, and before proceeding with the work. Should the CONTRACTOR fail to comply with this procedure, he shall alter his work at his own expense as directed by the ENGINEER.
- E. No additional payments will be allowed where obstructions in the work of other trades, or work under this contract requires offsets to conduit runs.
- F. The CONTRACTOR is responsible for all alterations in the work to accommodate equipment differing in dimensions or other characteristics from that shown or specified.
- G. The CONTRACTOR shall provide all temporary power necessary for existing site equipment and for all construction needs.

1.6 SUPERVISION

- A. The CONTRACTOR shall maintain adequate supervision of the work and shall have a responsible person in charge at the site during all times that work under this contract is in progress, or when necessary for coordination with other work.

1.7 CODES

- A. Work shall conform to the National Electrical Code (NEC), and State Codes and other applicable codes, even though not specifically mentioned for each item. These shall be regarded as the minimum standard of quality for materials and workmanship.

1.8 CONTRACTOR'S RECORD DRAWINGS & AS-BUILTS

- A. The CONTRACTOR shall maintain a neatly marked set of record drawings showing the locations of all buried conduits and other utilities encountered or installed during construction. The final locations of panels, field mounted instruments and panels, terminal boxes, junction boxes, receptacles, light switches and other materials included in the work shall be shown, as well as conduit routing between them to the extent it differs from the design drawings. Record drawings shall be kept current with the work as it progresses and shall be subject to inspection by the OWNER's Representative at any time. Failure to keep field record drawings current may result in the issuance of a stop work order or delay in the processing of pay requests until the record drawings are made current.
- B. The CONTRACTOR shall provide one complete set of as-built electrical schematics for all panels and equipment provided, including PLC I/O schematics as applicable, panel elementary diagrams, interconnecting wiring diagrams, wire numbers, termination strip locations and numbers. These shall be in the same format and style as those in the Contract Documents and submittal requirements.
- C. All information shown on the CONTRACTOR's field record drawings and as-built schematics shall be subject to verification by the OWNER's Representative. If significant errors or deviations are noted by the OWNER's Representative, new as-builts shall be completed at the CONTRACTOR's expense.

PART 2 PRODUCTS

2.1 PORTABLE OR DETACHABLE PARTS

- A. The CONTRACTOR shall retain in his possession and shall be responsible for all portable and detachable parts or portions of installations such as fuses, key locks, adapters, blocking chips and inserts until completion of his work.
- B. These parts shall be delivered to the ENGINEER and an itemized receipt obtained. This receipt, together with 2 copies of the final inspection certificate, shall be attached to the CONTRACTOR's request for final payment.
- C. All equipment shall be demonstrated to operate in accordance with the requirements of this specification and the manufacturer's recommendations.

2.2 NEW PRODUCTS

- A. All products shall be new without defects and covered by Manufacturer's warranty. Products shall be re-used only where indicated on the Drawings.
- B. All products shall be listed, labeled, and certified by a testing agency approved by the state of Oregon.
- C. All equipment of the same type and capacity shall be by the same manufacturer.

PART 3 EXECUTION

3.1 IDENTIFICATION

- A. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.

3.2 WORKMANSHIP & COORDINATION

- A. All work shall be performed by personnel skilled in the particular trade in a workmanlike manner. Workmanship shall conform to the standards of the NEC and the National Electrical Installation Standards (NEIS).
- B. The ENGINEER shall be the sole judge as to whether or not the finished work is satisfactory; and if in his judgment any material or equipment has not been properly installed or finished, the CONTRACTOR shall replace the material or equipment whenever required, and reinstall it in a manner entirely satisfactory to the ENGINEER without any increase in cost to the OWNER.
- C. The CONTRACTOR shall coordinate and verify the installation of all equipment furnished by him to other trades, or equipment provided and installed by other trades that is connected to the electrical or control systems. Work shall include the furnishing of all labor, materials, and equipment required for the installation of a complete and operable system as hereinafter specified and as indicated on the drawings. The Contract Documents are complementary and what is called for by any one shall be as binding as if called for by all. Unless otherwise specifically stipulated, the term "furnished and installed complete" shall be considered a part of this section.
- D. Controls and systems shall be complete with transformers, switches, relays, contactors, control valves, control devices, instrument piping, fittings, valves, control wiring, thermometers, pressure gauges, thermostats, damper operators, miscellaneous control cabinets to fill the intent of the Specifications and shall provide control for the various units and systems. All control valves and motorized dampers shall be provided with position indicators.
- E. Unless otherwise specified or shown on the drawings, switches or relays shall be installed in, or adjacent to the motor starter or other electrical device to which they are

to be connected. Control and interlock wiring shall be included as necessary from breakers specified herein or shown on the drawings.

- F. Each control schematic intended to control a series of motor operated louvers, fans, and thermostats shall contain a switch for maintenance to meet the NEC requirements regarding disconnect switches for motors. This switch shall be local if any unit controlled is out of sight of the switch. This switch shall disconnect all power to all motor operated devices within the circuit.

3.3 SUPPORT BACKING

- A. Provide any necessary backing, equipment stands and mounting plates as required to properly support all fixtures and equipment installed under this contract.

3.4 CUTTING, PATCHING AND FRAMING

- A. The CONTRACTOR shall determine in advance the locations and sizes of all sleeves, chases, and openings necessary for the proper installation of his work.
- B. Whenever practical, inserts or sleeves shall be installed prior to covering work. Cutting and patching shall be held to a minimum. All required holes in concrete construction shall be made with a core drill and patched with non-metallic non-shrink grout.
- C. Cutting, fitting repairing and finishing of carpentry work, metal work, or concrete work, and the like, which may be required for this work shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner as not to weaken walls, partitions, or floors; and holes required to be cut in floors must be drilled without breaking out around the holes.

3.5 TESTS

- A. The CONTRACTOR shall furnish all labor, material, instruments and tools to make all connections for testing of the electrical and instrumentation installation. All equipment shall be demonstrated as operating properly prior to the acceptance of the work. All protective devices shall be operative during testing of equipment. The tests shall be made under the supervision of the ENGINEER. All deficiencies or unsatisfactory conditions as determined by the ENGINEER or inspecting authorities shall be corrected by the CONTRACTOR in a satisfactory manner at his own expense.
- B. After visual inspection of joints and connections and the application of tape and other insulating materials, all sections of the entire wiring system shall be thoroughly tested for shorts and grounds. A log of results for each circuit shall be kept by the CONTRACTOR and presented to the ENGINEER.
- C. A phase rotation check shall be made to demonstrate that all power receptacles, service feeders, main power feeders and auxiliary power generators have the same A - B - C phase rotation and ground relationships.

- D. Equipment shall be tested by operating all electric motors, relays, controls, switches, heaters, etc., sufficiently to demonstrate proper installation and electrical connections. Control and emergency conditions shall be artificially simulated where necessary for complete system or subsystem.

3.6 CLEANING AND TOUCH-UP PAINT

- A. Upon completion of work, all electrical equipment shall be cleaned.
 - 1. Vacuum all dirt, metal shavings, and foreign materials from all enclosures. The use of compressed air shall not be acceptable.
 - 2. All stains, dirt, and fingerprints shall be removed from switchboards, motor control centers, panelboards, light fixtures, enclosures, and all other electrical equipment covers.
- B. Provide touch-up paint on equipment that has been scraped, scratched, or chipped during construction. Paint color shall match color of equipment.

3.7 COORDINATION OF STARTUP AND ADJUSTING, COMMISSIONING, DEMONSTRATION AND TRAINING, AND OPERATION AND MAINTENANCE DATA.

- A. Reference Section 16001 - Commissioning, 16010 - Operation and Maintenance Data, and 16015 - Demonstration and Training, for detailed requirements.

END OF SECTION

SECTION 16001
COMMISSIONING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. Definitions
 - 2. Requirements for commissioning.

1.2 DEFINITIONS

- A. Commissioning Verification Period.
 - 1. The commissioning period begins after the ENGINEER has approved the Functional Test Certification demonstration with the control software, the specified demonstration and training is complete, punch list deficiencies are corrected and the final operation and maintenance manuals are submitted and approved. The duration of the commissioning verification period is 14 days without significant interruption.
- B. Significant Interruption.
 - 1. Significant interruption may include any of the following events.
 - a. Failure of the CONTRACTOR to maintain qualified onsite start-up personnel as specified.
 - b. Failure of critical equipment unit, system, or sub-system that is not satisfactorily corrected within two (2) hours after the failure.
 - c. Failure of noncritical equipment unit, system, or sub-system that is not satisfactorily corrected within twenty-four (24) hours after the failure.
 - d. As may be determined by the ENGINEER.

1.3 REQUIREMENTS FOR COMMISSIONING

- A. Commissioning of the facility shall be completed prior to substantial completion.
- B. CONTRACTOR shall provide for realistic durations in the progress schedule for the commissioning activities.
- C. Provide the labor, tools, equipment and services required for, and incidental to, completing commissioning.
- D. Demonstrate satisfactory operation within the facility of the equipment and systems in actual operation as a functional unit.
- E. Conduct commissioning for a period of fourteen (14) continuous days without significant interruption.

- F. The commissioning verification period shall restart with the correction of each significant interruption.
- G. Correct defects in material and workmanship immediately following their discovery.
- H. Provide for maintenance until substantial completion. This includes the required maintenance activities during the commissioning verification period.
- I. Perform maintenance pursuant to the operation and maintenance data requirements for the new facility during and following the commissioning verification period and prior to issuance of a certificate of substantial completion.
- J. As of the date of substantial completion, OWNER's staff shall be responsible for operation and maintenance of the new facilities. This excludes any issues identified as warranty matters.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 16010

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Definitions.
 - 2. General requirements.
 - 3. Submittal procedures.
 - 4. Content requirements for manuals.
 - 5. Supplements.

1.2 DEFINITIONS

- A. Maintenance Operation.
 - 1. Routine operation required to ensure satisfactory performance and longevity of the equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands and other routine adjustments.

1.3 GENERAL REQUIREMENTS

- A. Provide operation and maintenance data for items listed in Supplement 16010 – A, “Schedule of Equipment Requiring Operation and Maintenance Data”.
- B. In addition to the composite of manuals for individual equipment items or systems, provide a consolidated summary of required routine scheduled maintenance and scheduled preventative and predictive maintenance for the project, with reference to where detailed information may be found. Include safety information and emergency plans and procedures. The summary shall be in a separate binder from the other equipment and system binders.
- C. Comply with the following format relating to the Operation and Maintenance Manual:
 - 1. All binders shall be “D” ring type with one-touch ring locking mechanism.
 - 2. Overlay material shall be crystal clear poly.
 - 3. Binders shall be black poly.
 - 4. Binders shall be nominally sized for 75 percent fill per volume with a maximum binder depth of four (4) inches and a minimum depth of one (1) inch.
 - 5. Submit example binder cover sheet for approval by ENGINEER.
 - 6. Submit example spine insert for approval by ENGINEER.
 - 7. Paper: twenty (20) pound minimum, white for typed pages, 8.5 x 11 inches.
 - 8. Text: Manufacturer’s printed data, or neatly typewritten. Facsimiles transmitted via fax machine shall be unacceptable.
 - 9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.

10. Provide fly-leaf for each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment. Provide with heavy section dividers with numbered plastic index tabs.
11. Provide each manual with a title page, typed table of contents with consecutive page numbers. Plan contents of entire set, identified by volume number, in each binder.
12. Material shall be suitable for reproduction with quality equal to the original. Photocopying of material will be acceptable except for material containing photographs.
13. Table of contents shall be neatly typewritten, arranged in a systematic order, containing as a minimum the following data:
 - a. CONTRACTOR, name of responsible principle, address and telephone number.
 - b. List of each product required to be included and indexed to content of each volume.
 - c. List of each product, name, address and telephone number of subcontractor, supplier, installer and maintenance contractor as appropriate.
 - d. Provide local source and phone number of supply for parts and replacement.
 - e. Identify each product by product name, model number and other identifying numbers or symbols as set forth in the Contract Documents.
14. Product data:
 - a. Include only those sheets that are pertinent to the specific product provided.
 - b. Clearly annotate each sheet to identify specific product or part installed, data applicable to the installation and delete references to inapplicable information.
15. Drawings; supplement product data with drawings as necessary to clearly illustrate the following:
 - a. Relationship of component parts of equipment and systems.
 - b. Control and flow diagrams.
 - c. Coordinate drawings with project record documents to assure correct illustration of completed installations.
 - d. CONTRACTOR shall not use project record documents as maintenance manual drawings.
 - e. Provide reinforced punched binder tabs.
 - f. Reduced 11 x 17 inch drawings shall be folded to 8.5 x 11 inch format.
 - g. Where reduction to 11 x 17 inch is impractical, fold and place the 8.5 x 11 inch envelopes that are bound in the binder.
 - h. Identify specification Section and product on drawings and envelopes.

1.4 SUBMITTAL PROCEDURE

- A. Compile the required data, arrange as specified herein and insert data in the number of volumes necessary. The volumes shall be submitted as a complete set. Partial or incomplete manuals shall be rejected by the ENGINEER.
- B. Preliminary Manuals:
 1. Submit three copies to ENGINEER for review and approval well before the starting and adjusting activities commence.

2. If accepted:
 - a. One copy will be returned to the CONTRACTOR.
 - b. One copy will be forwarded to the OWNER.
 - c. One copy will be retained in the ENGINEER's file.
 3. If rejected:
 - a. Two copies will be returned to the CONTRACTOR with ENGINEER's comments for revision.
 - b. One copy will be retained in the ENGINEER's file.
 - c. CONTRACTOR shall be required to resubmit three revised preliminary manuals for ENGINEER's review.
- C. Final Manuals:
1. Submit two copies to ENGINEER for review and approval before final completion.
 2. If accepted:
 - a. CONTRACTOR will be so notified.
 - b. CONTRACTOR shall provide a complete set of the final manual on DVD. Data written specifically for the manual will be presented in MS Word format. Manufacturer data (per-printed data) will be presented in Adobe PDF format.
 3. If rejected:
 - a. At the ENGINEER's discretion either all but one copy of the manuals will be returned to the CONTRACTOR for revisions or all copies will be retained by the ENGINEER and the necessary revision data will be requested from the CONTRACTOR.

1.5 CONTENT REQUIREMENTS FOR MANUALS

- A. The Operation and Maintenance Manuals shall normally consist of no less than two volumes outline below.
- B. Volume 1 – Equipment Manuals.
 1. Table of contents shall have a sheet protector
 2. Table of contents and index sheets shall be of colored card stock.
 3. Manuals for individual equipment shall not be divided between separate binders.
 4. List function, normal operation, characteristics and limiting conditions.
 5. Complete commercial part number and nomenclature of replaceable parts.
 6. Maintenance procedures including routine operations, guide to troubleshooting and adjustments.
 7. Manufacturer's printed operation and maintenance instructions.
 8. List of manufacturer's spare parts and recommended quantities to be maintained in storage. Warranty forms and information for all installed equipment provided by the CONTRACTOR.
 9. Circuit directories for all panels including electrical, control and communication.
 10. List of adjustable electrical relay settings, control and alarm settings.
 11. Contents for Maintenance Summary Manual:
 - a. Compile individual maintenance summaries for each applicable equipment item, respective unit or system and for components or subunits.

- b. Format shall include use of the Supplement 16010 – B “Maintenance Summary” provided. Each Maintenance Summary may take as many pages as required. Supplement shall be typewritten and shall include detailed lubrication instructions and diagrams showing points to be greased or oiled, recommended type, grade and temperature range of lubricants and frequency of lubrication.
 - c. Include a list and quantity of manufacturer’s recommended consumable and spare parts that should be stored on site.
- C. Volume 2 – Drawings
- 1. As-built drawings associated with the project shall be provided. This includes, but is not limited to, manufacturers supplied drawings. All drawings shall be provided on 11 x 17 inch sheets folded to 8.5 x 11 inch size and bound in this volume. A complete and detailed index shall be provided that includes a list of all drawings in the volume and the drawings shall be tabbed in a fashion that provides clear and concise identification.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 SUPPLEMENTS

- A. Supplement 16010 – A, “Schedule of Equipment Requiring Operation and Maintenance Data”.
- B. Supplement 16010 – B, “Maintenance Summary Form”.

END OF SECTION

Supplement 16010 – A
 Schedule of Equipment Requiring Operation and Maintenance Data

Item No.	Section	Manual (M) Data Sheet (D)	Description
1	11220	(D)	Submersible Mixers
2	16440	(D)	Panelboards

END OF SUPPLEMENT

Supplement 16010 – B
Maintenance Summary Form

Project Name _____ Project Number _____

Equipment _____

Equipment ID Tag Number _____

Manufacturer _____

Name Plate Data _____

Manufacture’s Local Supplier Name _____

Phone _____

Address _____

Maintenance Requirements

Maintenance Requirements	Frequency Required	Lubricant if Required

END OF SUPPLEMENT

SECTION 16015

DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. Definitions.
 - 2. General Requirements.
 - 3. Supplements.

1.2 DEFINITIONS

- A. Training Requirements.
 - 1. The following topics shall be covered at a minimum:
 - a. Equipment schematics.
 - b. Control strategy.
 - c. Troubleshooting procedures.
 - d. Recommended maintenance and periodic testing procedures.
 - e. Advanced start-up procedures.
 - f. Control Input/Output (I/O) and communications review.
 - g. Operator Interface Terminals (OIT) operating characteristics and navigation between various screens and functions.
 - h. Proper use and function of selector switches, reset buttons, speed controls, E-stops, etc.
 - 2. Training shall require one session for each type of process equipment.
- B. Manufacturer's Representative / Factory Trained Technician.
 - 1. Shall be an authorized service division employee of the manufacturer.

1.3 GENERAL REQUIREMENTS

- A. Provide training for OWNER's personnel for items listed in Supplement 16015 – A, "Schedule of Equipment Requiring Demonstration And Training".
- B. Utilize Manufacturer's Representative to conduct training sessions.
- C. CONTRACTOR shall have an employee familiar with the details of the installation attend the training sessions.
- D. The Manufacturer's Representative and CONTRACTOR shall provided the demonstration and training required to meet the performance specified herein. No costs in addition to the original Bid shall be incurred by the OWNER to meet this requirement.

- E. Schedule and coordinate training sessions to accommodate the following:
 - 1. Provide fourteen (14) day written notice to the ENGINEER for approval prior to proposed training sessions.
 - 2. Do not schedule training sessions for Monday, Friday, Saturday, Sunday or a Holiday.
 - 3. No more than two (2) different types of equipment training sessions shall be scheduled for any one (1) day.
 - 4. The Manufacturer's Representative shall utilize the operation and maintenance manuals as a basis for instruction. Should the need for additional data become apparent during instruction, CONTRACTOR shall prepare and insert the additional data into the operation and maintenance manual within seven (7) business days.
 - 5. OWNER reserves the right to video tape the training session. The OWNER agrees that the video tape shall only be used for training employees.
 - 6. Provide the material, data, and training aids including, but not limited to, the copying of any documents, screens, viewers, etc. required for training session.
 - 7. Provide an outline of the topics for discussion during the training session and copies of the operation and maintenance manuals for all training session participants.
 - 8. OWNER will provide the CONTRACTOR with the number of participants at each training session seven (7) days after receipt of the proposed training session schedule.

- F. ENGINEER shall not authorize the commencement of the demonstration and training sessions until after successful demonstration of the Functional Test Certification, approval of the test reports submitted from Section 16080 – Electrical Testing.

- G. Should the CONTRACTOR fail to meet the scheduled training session date, OWNER shall be entitled to notification of a new date complying with the requirements indicated herein.

- H. Training sessions shall be scheduled to allow for appropriate progression of the training material. If knowledge of certain equipment is necessary to adequately comprehend the operational and maintenance aspects of another piece of equipment, the training session shall be scheduled to provide for this requirement.

- I. Training sessions shall meet the following general requirements:
 - 1. Training sessions shall be completed before commissioning.
 - 2. CONTRACTOR shall provide the labor, process medium, chemical, tools, equipment and instruments necessary to accommodate demonstration of the equipment. CONTRACTOR may not rely on adequate water, wastewater, storm water or other normal process flows, etc. as they may not be available.
 - 3. The content of the training sessions shall be specific to the products installed.
 - 4. The training sessions shall be developed to allow for appropriate presentation of information and hands-on operation and maintenance opportunities for the OWNER's staff.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 SUPPLEMENTS

- A. Supplement 16015 - A, “Schedule of Equipment Requiring Demonstration And Training”.

END OF SECTION

SECTION 16057

ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. The section includes the requirements for a Short-Circuit Study, Protective Device Coordination Study, Arc Flash Study, and Arc Flash Warning Labels.

1.2 REFERENCES

A. Referenced Standards:

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers (IEEE):
 - a. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - b. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
 - c. 1584, Guide for Performing Arc Flash Hazard Calculations.
3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - b. 70E, Standard for Electrical Safety in the Workplace.
5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910, Subpart S, Electrical.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16057.S21) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly

identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data:

1. Provide product data on all components specified.
2. Arc Flash Warning Label templates.

1.4 QUALITY ASSURANCE

- A. Short circuit, protective device coordination, and arc flash studies shall be provided by a corporately and financially independent, unbiased, testing authority. The testing authority shall be independent of manufacturers, suppliers, and installers of equipment being tested. The testing authority shall have a minimum of five (5) years experience testing similar projects.

1.5 SEQUENCING AND SCHEDULING

- A. Initial complete protective device coordination and arc flash studies shall be submitted within 90 days after approval of initial short circuit study.
- B. Revised short circuit, protective device studies, arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.
- C. Final short circuit, protective device studies, and arc flash studies shall be completed prior to project completion. Final version of study shall include as-built equipment, materials, and parameter data or settings entered into equipment based on study.
- D. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to project completion.

1.6 GENERAL STUDY REQUIREMENTS

1. The study shall pertain to the entire electrical service and all associated distribution equipment.
- B. The CONTRACTOR shall be responsible for providing all information to the Agent responsible for performing the Study. At minimum, the CONTRACTOR shall provide the following:
1. Service transformer nameplate information
 2. Service entrance feeder conductor size, type, length and feeder conduit size, type, and length.
 3. Service entrance equipment nameplate information.
 4. Motor load nameplate information.
 5. Distribution feeder size, type, and length.
 6. Overcurrent protection device nameplate information and trip settings.
 7. Panelboard nameplate information.
- C. Any other information requested by the testing Agent

- D. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on the Drawings.
- E. Perform studies using one of the following electrical engineering software packages:
 - 1. SKM Power Tools for Windows
 - 2. ETAP
 - 3. EDSA
 - 4. Easy Power
- F. Perform complete fault calculations for all new and future loads indicated on the Drawings.
- G. Provide individual protective device time-current characteristics for the low voltage distribution system.

PART 2 STUDIES AND PRODUCTS

2.1 SHORT CIRCUIT STUDY

- A. General
 - 1. Prepare a Short Circuit Study in accordance with IEEE 39.
 - 2. Cable impedances shall be based on copper conductors.
 - 3. Bus impedances shall be based on copper buses.
 - 4. Cable and bus resistances shall be calculated at 25 degrees Celsius.
 - 5. Medium voltage cable reactance shall be based on typical dimensions for standard cables with 133% insulation levels.
 - 6. 600-volt cable reactance shall be based on the typical dimensions of THWN-2 conductors.
 - 7. Transformer impedances shall be 92.5% of nominal impedance based on tolerances specified in IEEE C57.12.00.
- B. The Short Circuit Study final report shall include the following:
 - 1. Basic description, purpose, and scope of the study.
 - 2. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate short circuit ratings.
 - 3. Explanation of bus and branch numbering system.
 - 4. Prevailing conditions.
 - 5. Selected base per unit quantities.
 - 6. Source impedance data, including electric utility system, generator, and motor fault contribution characteristics.
 - 7. Impedance diagrams.
 - 8. Zero-sequence impedance diagrams.
 - 9. One line diagrams and associated tabulations of data used to model the system components.
 - 10. Calculation methods and assumptions.
 - 11. Typical calculations.
 - 12. Tabulation of calculation quantities.

13. Results, conclusions, and recommendations.
- C. The short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault shall be calculated at each:
 1. Utility Service point.
 2. Medium Voltage Switchgear.
 3. Low Voltage Switchgear.
 4. Switchboard.
 5. Motor Control Center.
 6. Automatic Transfer Switch.
 7. Distribution Panel.
 8. Branch Circuit Panelboard.
 9. Future load contributions as shown on the One-Line Diagram.
 10. Any additional point within the power distribution system as specified by the Engineer.
 - D. The Short Circuit Study shall be used to verify the following:
 1. Equipment and protective devices are applied within their ratings.
 2. Adequacy of distribution equipment bus bars to withstand short circuit stresses.
 3. Cable and bus way sizes for ability to withstand short circuit heating, in addition to normal current loads.
 - E. Provide a tabulation of equipment short circuit versus available fault duties. The tabulation shall identify percentage of rated short circuit current and clearly identify equipment with insufficient ratings.
 1. General Data
 - a. Short circuit reactance of rotating machines.
 - b. Cable and conduit material data.
 - c. Bus data.
 - d. Transformer data.
 - e. Circuit resistance and reactance values.
 2. Short Circuit Data
 - a. Fault impedances.
 - b. X/R ratios.
 - c. Asymmetry factors.
 - d. Motor contributions.
 - e. Short circuit kVA.
 - f. Symmetrical and asymmetrical fault currents.
 3. Equipment Evaluation
 - a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
 - b. Maximum fault current available.
 - F. Provide a written summary at the end of the Short Circuit Study, which shall include the following:
 1. Selected equipment deficiencies.
 2. Results of short circuit study.

3. Conclusions and recommendations.
- G. The Contractor shall be notified in writing of existing circuit protective devices improperly rated for new fault conditions.
- H. The Short Circuit Study data shall be revised for as-built conditions.

2.2 ARC FLASH STUDY

- A. Perform an Arc Flash Hazard Study after short circuit and protective device setting recommendations have been completed, reviewed, and accepted by the Engineer. Perform the analysis under worst-case arc flash conditions for all modes of operation. Provide an analysis of all operating scenarios which will be or have been influenced by the proposed or completed additions to the subject system.
- B. The Arc Flash Hazard Study shall be performed in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.
- C. The Arc Flash Hazard Study shall include the following:
 1. Basic description, purpose, and scope of the study.
 2. One Line Diagram.
 3. Short Circuit Study.
 4. Protective Device Settings Study.
 5. Calculation methods and assumptions.
 6. Typical calculation.
 7. Evaluation summary spreadsheet.
 8. Conclusions and recommendations.
- D. Base Calculation: For each major part of the power distribution system, the following shall be determined:
 1. Flash hazard protection boundary.
 2. Limited approach boundary.
 3. Restricted approach boundary.
 4. Prohibited approach boundary.
 5. Incident energy level.
 6. Personal protection equipment (PPE) hazard/risk category.
 7. Type of PPE required.
- E. Produce arc flash warning labels that list items in Part C above and provide the following additional items:
 1. Bus name.
 2. Bus voltage.
- F. Produce detail sheets that list items in Part C above and the following items:
 1. Bus name.
 2. Upstream protective device name, type, and settings.
 3. Bus-to-line voltage.

- G. Produce arc flash evaluation summary sheet listing the following additional items:
 - 1. Bus name.
 - 2. Upstream protective device name, type, and settings.
 - 3. Bus-to-line voltage.
 - 4. Protective device bolted fault current.
 - 5. Arcing fault current.
 - 6. Protective device trip/delay setting.
 - 7. Breaker opening time.
 - 8. Solidly grounded column.
 - 9. Equipment type.
 - 10. Gap.
 - 11. Arc flash boundary.
 - 12. Working distance.
 - 13. Incident energy.
 - 14. Required protective fire rated clothing type and class.
- H. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 40 cal/cm². Provide proposals to reduce energy levels.
- I. Provide a written summary at the end of the Arc Flash Hazard Study, which shall include the following.
 - 1. Equipment manufacturer's information used to prepare study.
 - 2. Assumptions made during study.
 - 3. Copy of one line diagram.
 - 4. Arc flash evaluations summary spreadsheet.
 - 5. Bus detail sheets.
 - 6. Arc flash warning labels printed in color on adhesive backed labels.

2.3 ARC FLASH WARNING LABELS

- A. Provide arc flash warning labels per NEC 110.16
- B. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.

PART 3 EXECUTION

3.1 GENERAL

- A. Adjust relay and protective device settings according to reduce arc flash while maintaining coordination between downstream circuit breakers and the upstream main circuit breaker.
- B. Perform minor modifications to equipment as required to accomplish conformance with short circuit study.

- C. Notify Contractor in writing of required major equipment modifications.
- D. Provide laminated one-line diagrams (minimum size 11" x 17") to post on interior of electrical room doors.
- E. Provide arc flash warning labels on equipment as specified on this Section.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes.

1. The section includes requirements for grounding electrodes, equipment grounding and electrical bonding.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16060.G01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, methods of installation and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Ground Rods (16060.G01).**

1. Ground rods shall be provided as shown on the drawings.
2. Ground rods shall be copper clad.
3. Ground rods shall be a minimum of 5/8 inch diameter.
4. Ground rods shall be a minimum of 10 feet long.

B. Compression Connectors (16060.C20).

1. Compression connections shall be provided as shown on the drawings and as required for bonding end-use equipment.
2. Compression connections shall be compress-deforming type, extruded copper material.
3. Compression connections shall be tin electroplated for corrosion resistance.
4. Compression connections shall be ring-type connectors. Forked connectors shall not be used on grounding conductors.
5. Provide Burndy products, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Bond separately derived systems, including generators, to the grounding electrode system.
3. Maintain equipment ground continuity throughout the facility by means of a grounding conductor routed in all raceways.
4. Provide grounding conductors pursuant to Section 16121. Conductors shall be copper and shall be sized per the Drawings or the NEC, whichever is greater.
5. Provide ground bushings for all conduits that do not terminate in a hub type fitting and install at the source of power with a bonding conductor fastened to the ground bushing.
6. Install ground rods at the locations and in the number shown on the Drawings or per the NEC, whichever is greater.
7. Bond the grounding electrode system to all metallic water and wastewater piping.

B. Grounding Conductors.

1. Brush grounding conductors clean of debris before connections are made.
2. Strip insulated conductor insulation in a neat, workman like manner where insulated conductors are used.
3. Fasten all conductors securely.

C. Connections.

1. Install connectors according to the manufacturer's directions, using the proper tools, molds, etc. designed specifically for this purpose.
2. Provide irreversible compression type connections to ground rods, re-bar, lightning protection box, building steel etc.
3. Provide compression connector type connections to end use equipment and bolt to the equipment using washers and split lock washers for secure fastening. Bolts shall be grade 5 for grounding connections and shall be tightened to the manufacturer's recommend torque.

END OF SECTION

SECTION 16070

HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. This section includes requirements pertaining to electrical equipment anchoring and electrical equipment hanging and support.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16070.H01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data.

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Galvanized Hardware (16070.H11).**

1. Bolts shall be hot dipped galvanized steel and sized for the load served and have a hex head unless specifically specified otherwise elsewhere.
2. Nuts shall be hot dipped galvanized steel hex nut.
3. Washers shall be hot dipped galvanized steel, USS pattern flat washers.
4. Split lock washers shall be hot dipped galvanized steel.

5. Threaded rods and couplings shall be hot dipped galvanized steel.
6. Eye-bolts, u-bolts, bent-bolts and similar connecting hardware shall be hot dipped galvanized steel.

B. Galvanized Anchors (16070.A11).

1. Wedge or stud anchors installed in concrete or masonry shall be hot dipped galvanized steel and sized for the load served.
2. Toggle type fasteners shall only be used in hollow sheetrock wall. The wing part of the fastener may be mild steel, but the bolt shall be hot dipped galvanized steel.

C. Galvanized Beam Clamps (16070.B11).

1. Beam clamps shall be hot dipped galvanized steel and sized for the load served.

D. Galvanized Strut Channel (16070.S01).

1. Galvanized strut channel shall be hot dipped galvanized after fabrication and shall be a minimum of 12 gauge.
2. Galvanized strut channel shall have factory pre-drilled holes.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. Hardware shall be set to a torque as recommended by the manufacturer.
2. Washers and split lock washers shall be installed on all bolts, threaded rods and anchors.
3. Lead or plastic type anchors are prohibited from use on the project.
4. When threaded rods are installed in drop-in type anchors, a washer, split lock washer and a jamb nut shall be installed at the anchor to ensure stability.
5. When channel (strut) is installed as a hanger or support from threaded rod, washers, split lock washers and jamb nuts shall be installed on both sides of the strut to lock it in place.
6. Cut ends of channel, strut, threaded rods or other cut fittings shall be filed smooth before installation.
7. Cut ends of hot dipped galvanized channel and strut shall be coated with three coats of cold galvanizing compound after the channel has been filed to prohibit rust.
8. Concrete anchors shall be installed as per the manufacturer's directions and set using the manufacturer's supplied tool.
9. Threaded rod shall not extend more than one (1) inch beyond the channel, strut or other material it is supporting.
10. Hangers and supports shall be installed level and plumb.
11. Hangers and supports shall be installed per the National Electrical Code, Building Code and Structural Code and shall be designed to safely support the load. The ENGINEER may request the CONTRACTOR provide a copy of their design calculations for the seismic requirements and the load served.

END OF SECTION

SECTION 16075

ELECTRICAL AND CONTROL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Requirements for identification of electrical, safety, measurement, data, fire alarm, security, monitoring, control and related components and equipment.

1.2 SUBMITTALS

A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16075.S21) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data

1. Provide product data on all components specified.
2. The initial submittal shall contain all the products, samples and data base specified. An initial submittal that does not contain all the specified data shall be returned as incomplete.

C. Samples

1. Provide a sample of each type and size of nameplate, label, tag and means of attachment specified for approval by the OWNER.

PART 2 PRODUCTS

2.1 MATERIALS

A. **Circuit Breaker Panel Schedules (16075.S21).**

1. Shall be created in Microsoft Excel software. One copy of each schedule shall be included in the closeout submittals.
 2. Shall be printed on 60 - 70 lb white card stock.
- B. Heat Sealing Lamination Products (16075.L11).**
1. Provide documents in laminate when specified. Laminate shall be clear, non-yellowing and sized for various sized documents.
 2. Shall be 5 mil. in thickness.
- C. Velcro (16075.V15).**
1. Provide white Velcro.
- D. Plastic Nameplates (16075.P05).**
1. Shall have a white background with black engraved letters. Nameplates for emergency functions shall be red background with black engraved letters. The nameplates shall have self adhesive rated for the environment which they are installed. The font type shall be consistent on all nameplates.
 2. Provide products supplied by E.R. Perry Signs & Engraving, or approved equal.
- E. Stainless Steel Component and Device Tags (16075.S25).**
1. Shall be stainless steel.
 2. Two (2) inch round.
 3. The tag shall be between .025 - .050 inches thick.
 4. The text shall be center justified and shall be stamped.
 5. Standard size for characters shall be 0.25 inches high.
 6. The stainless steel tags shall be attached to devices with stainless steel beaded chain which shall be provided with two (2) to three (3) inches of slack when the tag is attached to the device. The hole in the tag for the beaded chain shall be at the top and centered on the tag. The hole shall be large enough that the chain will not bind in the hole.
 7. Provide products supplied by E.R. Perry Signs & Engraving, or approved equal.
- F. Conduit Tags (16075.S35).**
1. Shall be 316 or 304 stainless steel.
 2. Nominally 0.75 inches high by 3.0 inches long.
 3. Characters shall be 0.25 inches high. And shall be machine punched or durably embossed.
 4. Conduit tags shall be products readily available and manufactured for this purpose.
 5. The stainless steel conduit tags shall be attached with stainless steel cable ties.
 6. Provide Panduit Permanent Identification System products, or approved equal.
- G. Conductor and Cable Identification Sleeves (16075.T31).**
1. The identification sleeves shall be properly sized for the cable or conductor.
 2. Sleeves shall be white with black machine generated characters.
 3. Provide Brady wire and cable sleeves, or approved equal.
- H. Flexible Identification Tape (16075.T56).**

1. Shall be white, red, yellow, clear or as otherwise specified tape with black characters.
2. Standard tape size shall be 0.5 inch high unless specified otherwise and shall have extra strength adhesive rated for indoor and outdoor use.
3. Provide products manufactured by Brother, or approved equal.

I. Arc Flash Labels (16075.A11).

1. Reference Section 16057 – Electrical Systems Analysis for additional details.
2. Shall be self adhesive and manufactured specifically for this purpose.
3. Shall be four (4) inches high by six (6) inches wide minimum.
4. Shall be based on the latest edition requirements of the National Fire Protection Association (NFPA) 70E – Standard for Electrical Safety.
5. At a minimum the label shall contain the following information.
 - a. Date calculation was performed and who did the calculation.
 - b. Danger or Warning level based on the incident energy. When above 40 cal/cm sq. the label shall read “Danger”.
 - c. Shall identify the hazard as being both arc flash and shock hazard.
 - d. Shall clearly state the incident energy and the level of personal protective equipment (PPE) required.
 - e. Provide labels manufactured by Dura Label, SKM System Analysis, Inc., or approved equal.

J. Conductor Color Coding (16075.C89).

1. Conductors shall be colored as specified in the table below. The technical specification requirements for the conductors are specified elsewhere.

Conductor Color Coding

System	Conductor	Color
All Systems	Equipment Grounding	Green
IT / Data	Data Cable Sheath (outer cover)	Blue
24 Volt DC	Positive	Blue
	Negative	White w/Blue Stripe
	Discrete Input Line (hot leg) Side	Blue
	Discrete Input Switch Leg	Blue w/White Stripe
	Discrete Output Line (hot leg) Side	Blue
	Discrete Output Switch Leg	Blue w/Orange Stripe
24 Volt AC	Hot Leg	Red
	Neutral	White
	Discrete Input Line (hot leg) Side	Red
	Discrete Input Switch Leg	Red w/Blue Stripe
120 Volt AC Control	Hot Leg	Red
	Neutral	White
	Discrete Input Line (hot leg) Side	Red
	Discrete Input Switch Leg	Red w/White Stripe
	Discrete Output Line (hot leg) Side	Red
	Discrete Output Switch Leg	Red w/Orange Stripe
120/240 Volt Single Phase	Hot Leg # 1	Black
	Hot Leg # 2	Red
	Neutral	White
120/208 Volt Three Phase	Phase A	Black
	Phase B	Red
	Phase C	Blue
	Neutral	White
120, 208, 277 Volt	Switch Legs	Pink
480 Volt Three Phase	Phase A	Brown
Wye or Delta Corner Tap	Phase B	Purple
	Phase C	Yellow
	Neutral	Gray
120/240 Delta Three Phase	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
	Neutral	Gray

PART 3 EXECUTION

3.1 INSTALLATION

A. Circuit Breaker Panel Schedules

1. CONTRACTOR shall request panel schedules in Microsoft Excel software and printing instructions from ENGINEER. CONTRACTOR shall update the panel schedules to reflect as-built conditions. Print schedules on 60 - 70 lb white card stock with black ink.
2. Schedules shall be neatly trimmed with 1/8" white space borders.
3. The finished schedules shall be laminated and neatly trimmed with 1/8" of laminate border.
4. A sample layout shall be submitted to OWNER for approval prior to installation.
5. Attach white Velcro to the panel door and the back of the panel schedule. Velcro shall, at a minimum, be attached to all four corners of the panel schedule.

B. Plastic Nameplates

1. Provide plastic nameplates for panelboards, motor control centers, motor starters, disconnects, variable frequency drives, control panels and similar equipment. The verbiage on the nameplate shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available on the Contract Drawings.
2. In addition to the nameplate identifying the equipment, a second nameplate shall be provided that identifies the source of power for the equipment i.e. "Fed From PNL208-1".
3. Typically the nameplates shall be centered and installed near the top of the equipment.
4. Nameplates shall be black with white characters unless specified otherwise.
5. Nameplates on emergency panels shall be red with white characters.

C. Stainless Steel Component and Device Tags

1. Provide stainless steel component and device tags for instruments, valves, pipes and similar equipment.
2. The tag shall be attached with a stainless steel beaded chain and attached in a manner and location which enables it to be read without interfering with the operation of the component or device. Whenever possible it shall not be attached to a removable part of the equipment.
3. The verbiage on the tag shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available on the Contract Drawings.

D. Conduit Tags

1. Provide stainless steel conduit tags at each point that a conduit terminates at or within an enclosure or box. The stainless steel tag shall be attached with stainless steel cable ties.

2. The verbiage on the tag shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available on the Contract Drawings.

E. Conductor and Cable Identification Sleeves

1. Provide heat shrink, machine generated, white labels with black characters for all cables and conductors. Explanation is provided below on how various systems shall be identified. In many cases the information necessary to develop the unique identification labels will be provided on the Contract Drawings. The verbiage required for the identification shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available or clear based on the information provided on the Contract Drawings.
2. The labels shall be installed between 6 to 8 inches from the end and shrunk. Conductors shall be labeled at all splices and points of termination.
3. Power conductors and cables, including the neutral and the ground conductors shall all be identified individually. The identification label will be developed as follows: The first set of characters will be the equipment code identifying the source of power "PNL-1" followed by the circuit number "CKT 12" and a forward slash followed by the utilization equipment name/number. A typical label might read "PNL-1 CKT 12 / UH-1".
4. Control and Ethernet cables & conductors, including grounds, shields, etc. shall be identified individually. The label shall identify the point of origin and the utilization equipment it serves. The identification label will be developed as follows: An sample label for a conductor fed from terminal strip 2, terminal block 33 in control panel # 1 (CP-1) to an terminal strip 1, terminal block 4 in automatic transfer switch # 1 (ATS-1) would read CP-1 TS2-TB33 / ATS-1 TS1-TB4.

F. Device and Faceplate Identification Labels

1. Devices, faceplates, security devices, fire alarm & life safety devices, small electrical boxes 4 inches or less located indoors and similar equipment shall be identified utilizing flexible identification tape. Typically the CONTRACTOR shall provide machine generated, white labels with black characters except as specified otherwise. Explanation is provided below on how various systems shall be identified. In many cases the information necessary to develop the unique identification labels will be provide on the Contract Drawings. The verbiage required for the identification shall be as identified on the Contract Drawings. The CONTRACTOR shall request the required verbiage from the ENGINEER should it not be available or clear based on the information provided on the Contract Drawings.
2. Power receptacles faceplates (cover plates) shall state the panel and circuit number. A typical label might read "PNL-1 / CKT 15".
3. Light switches faceplate shall state the panel and circuit number(s). A typical label might read "PNL-1 ' CKT 15&17".
Interior emergency light fixtures shall have a unique 0.5 inch adhesive dot applied to facilitate tracking routine maintenance required for emergency lighting. The dots shall be red when they have an integral battery back-up.

G. Arc Flash Labels

1. The CONTRACTOR shall install arc flash labels on all electrical equipment as required by the NEC and National Fire Protection Association (NFPA) 70E – Standard for Electrical Safety. The minimum requirements for the labels are itemized in PART 2 Products.
2. The CONTRACTOR shall be responsible for providing the coordination study and arc flash analysis necessary to calculate the incident energy and personal protective equipment (PPE) data required on each label.
3. An as-built coordination study and arc flash analysis shall be prepared at the Contractor's expense and be performed by a Professional Engineering licensed in the State of Oregon. The calculations shall utilize SKM Power Tools software and an electronic and hard copy shall be submitted to the Owner for approval. Arc Flash Labels with all data specified by the current edition of the NFPA 70E (Standard for Electrical Safety) and Occupational Safety & Health Administration (OSHA) shall be provided by the Contractor.
4. The CONTRACTOR is responsible to make the adjustments to the protective devices and circuit breakers as specified in the coordination study.

END OF SECTION

SECTION 16080
ELECTRICAL TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes
 - 1. Electrical and control testing forms and requirements.

1.2 SEQUENCING

- A. ENGINEER shall issue written acceptance of the following certifications submitted by the CONTRACTOR before utility power is supplied to conductors, cables, or equipment.
 - 1. Megger Test
 - 2. Continuity Test
- B. CONTRACTOR shall verify to ENGINEER that every function of the electrical, measurement, and control systems are operating properly.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Site Tests, Inspection
 - 1. CONTRACTOR shall be responsible to become familiar with the test and certification requirements of the Contract Documents for this project. It is the intent of these requirements that the Work will be systematically checked to verify that the functions required or implied, work properly to insure safety for the personnel, environment, and equipment associated with the Work.
 - 2. CONTRACTOR shall complete the certification forms that are supplemental to this section and submit the forms to ENGINEER for approval.
 - 3. All site test and inspection certificates and schedules shall be contained in a 3-ring binder(s).
 - a. Size 8½ inches by 11 inches.
 - b. Paper: 20-pound minimum, white for typed pages.
 - c. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
 - d. Provide each manual with title page to include “Process Electrical Testing”, typed table of contents with consecutive page numbers. Where more than one binder is used, consecutively title each with a volume number. The first binder

shall be labeled Volume 1 and consecutively numbered as required to include all test documentation.

- e. Tab sections for each required section of testing and acceptance certification.
- 4. CONTRACTOR shall notify ENGINEER seven days in advance of scheduled testing and facilitate the witnessing of those tests by ENGINEER.
- 5. CONTRACTOR shall provide ENGINEER with current as-built documentation for electrical and measurement and control commissioning with submittal of test certification.
 - a. Systems operating at or above 200-volts to ground or more shall be included in the Megger Test Certification. Minimum duration for each test shall be one minute, at 1000 VDC, and minimum acceptable results shall be 50 mega ohms.
 - b. Conductors and cables shall be included in the Continuity Test Certification. No continuity to ground is the only acceptable result of the test.
 - c. Conductors, cables, or equipment failing to meet the minimum requirements shall be replaced with new. Repair will not be acceptable.
 - d. Each individual instrument shall have an Instrument Calibration Certificate. The calibration shall operate within the tolerances specified by the manufacturer of the instrument and the Contract Documents.
 - e. Installed motors shall have a written Motor Insulation Certificate for all the motors listed in the Drawings for the Work. Motors failing test shall be tagged and locked out from operation.

3.2 SUPPLEMENTS

- A. Schedule 16080 - A; Megger Test Certificate.
- B. Schedule 16080 - B; Continuity Test Certificate.

END OF SECTION

SUPPLEMENT 16080 - A
MEGGER TEST CERTIFICATE

					Project Number:				
Test Equipment Manufacturer:		Model Number:			Project Name:				
Test Equipment Last Calibration Date:		Serial Number:			Accepted By:				
					Date:				
Testing Personnel:		Calibration Certificate			Drawing Reference:				
Test Voltage:		Test Date:			Title:				
					Tag:				
Title	Tag Identification	A-Ø/ B-Ø	A- Ø / C- Ø	A- Ø / Ground	B- Ø / Ground	C- Ø / Ground	A- Ø / Neutral	B- Ø / Neutral	C- Ø / Neutral

SUPPLEMENT 16080 - A

MEGGER TEST CERTIFICATE

				Project Number: <i>12345</i>					
Test Equipment Manufacturer: <i>APC</i>		Model Number: <i>GH-1</i>		Project Name: <i>Water Diversion</i>					
Test Equipment Last Calibration Date: <i>8/13/02</i>		Serial Number: <i>346321</i>		Accepted By: <i>S.E. Davis</i> Date: <i>01/01/2003</i>					
Testing Personnel: <i>John Doe</i>		Calibration Certificate: <i>Yes</i>		Drawing Reference: <i>E-006</i>					
Test Voltage: <i>1000 Volts</i>		Test Date: <i>12/17/02</i>		Title: <i>Power Distribution Diagram</i>					
				Tag: <i>016</i>					
Title	Tag Identification	A-Ø/ B-Ø	A- Ø / C- Ø	A- Ø / Ground	B- Ø / Ground	C- Ø / Ground	A- Ø / Neutral	B- Ø / Neutral	C- Ø / Neutral
<i>Main Feeder</i>	<i>016-CO3</i>	∞	∞	∞	∞	∞	∞	∞	∞
<i>PNL-07</i>	<i>016-CO7</i>	∞	∞	∞	∞	∞	∞	∞	∞
<i>PNL-12</i>	<i>016-C12</i>	∞	∞	∞	∞	∞	∞	∞	∞

SUPPLEMENT 16080 - B

CONTINUITY TEST CERTIFICATE

				Project Number:
Test Equipment Manufacturer:		Model Number:		Project Name:
Test Equipment Last Calibration Date:		Serial Number:		Accepted By:
Testing Personnel:		Calibration Certificate:		Date:
		Test Date:		Drawing Reference:
				Title:
				Tag:
Permanent Tag Number	Function	Temporary Tag Number	Device ID Number	Ohms to Ground

SUPPLEMENT 16080 - B

CONTINUITY TEST CERTIFICATE

				Project Number: <i>12345</i>	
Test Equipment Manufacturer: <i>Fluke</i>		Model Number: <i>53G</i>		Project Name: <i>Water Division</i>	
Test Equipment Last Calibration Date: <i>Unknown</i>		Serial Number: <i>638842</i>		Accepted By: <i>S.E. Davis</i> Date: <i>01/01/2003</i>	
Testing Personnel: <i>John Doe</i>		Calibration Certificate: <i>No</i>		Drawing Reference: <i>E-501</i>	
		Test Date: <i>12/30/02</i>		Title: <i>Conduit Schedule</i>	
S A M P L E					
Permanent Tag Number	Function	Temporary Tag Number	Device ID Number	Ohms to Ground	
<i>016-34-PNL</i>	<i>Level Indicator</i>	<i>34</i>	<i>016-34</i>	∞	

SECTION 16095

MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. Removal of existing electrical equipment, wiring and conduit in areas to be remodeled. Removal of designated construction, dismantling, cutting and alterations for completion of the Work.
 - 2. Disposal of materials.
 - 3. Storage of removed materials.
 - 4. Identification of utilities.
 - 5. Salvaged items.
 - 6. Protection of items to remain as identified in the schedules at the end of this Section.
 - 7. Relocate existing equipment.
 - 8. Removal of temporary electrical equipment prior to completion of the Work.

1.2 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
 - 1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
 - 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16095.S21) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 - 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
- B. Product Data.
 - 1. Provide product data on all components specified.
 - 2. Manufacturer's data including materials of construction, methods of installation and related information for each item specified.
- C. Shop Drawings.

1. Provide shop drawings indicating the location and construction of temporary work. Describe demolition procedures related to items listed in the schedules at the end of this Section.

1.3 CLOSEOUT SUBMITTALS

- A. Refer to the Contract Documents for general closeout submittal requirements.
- B. Project Record Drawings shall be provided that record actual locations of capped conduits and equipment abandoned in place.

1.4 SEQUENCING

- A. Sequencing of the Work shall be as noted in the Contract Documents.

1.5 SCHEDULING

- A. Refer to the Contract Documents.
- B. Coordinate the schedule of noisy, malodorous and dusty work with the ENGINEER.

1.6 COORDINATION

- A. Refer to Contract Documents.
- B. Conduct demolition to minimize interference with adjacent or occupied areas.
- C. Coordinate demolition work with other trades.
- D. Coordinate and sequence demolition so as not to cause shutdown or interruption of operation of surrounding areas.
- E. Arrange timing of shutdowns with the OWNER. Do not shutdown any utility service without prior written approval. Keep shutdown periods to a minimum.
- F. Identify salvage items in cooperation with the OWNER.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify wiring and equipment scheduled for demolition serve only abandoned process and facilities.
- B. Verify termination points for demolished services.

3.2 DEMOLITION

- A. Items scheduled for demolition shall be legally disposed of by the CONTRACTOR.
- B. Remove exposed abandoned conduit.
- C. Disconnect electrical systems in walls, floors and ceilings scheduled for removal.
- D. Reconnect equipment being disturbed by renovation work and required for continued service.
- E. Disconnect or shut off service to areas where electrical work is to be removed. Remove electrical fixtures, equipment, switches, receptacles, conduit, and conductors which are not part of the completed project.
- F. Install temporary wiring and connections necessary to maintain existing systems in service during construction.
- G. Remove, relocate and extend existing installations to accommodate new construction.
- H. Repair adjacent construction and finishes to original condition that are damaged during demolition and extension work.
- I. Remove abandoned grounding and bonding components, fasteners, supports and electrical identification components. Cut embedded support elements flush with wall, floors and ceilings.
- J. Clean and repair existing equipment scheduled to be reinstalled.
- K. Protect and retain power to existing active equipment remaining.
- L. Cap abandoned empty conduit at both ends.
- M. Provide water-tight, knockout seals in panels, enclosures, gutters, or junction boxes where conduit has been removed.
- N. Seal concrete penetrations, originally occupied by removed conduit, with suitable grouting material.

3.3 EXISTING PANELBOARDS

- A. Trace out circuits in existing panelboards and document the as-built conditions, including what each circuit feeds, the size of the conductors for each circuit and the total volt-amp load on each circuit.
- B. Remove all unused conductors due to scheduled demolition.
- C. Provided as-built panel schedules at the completion of the Work.

3.4 SALVAGE ITEMS

- A. Remove and protect items scheduled to be salvaged. Coordinate with OWNER where you are to locate these items.

3.5 REUSEABLE ELECTRICAL EQUIPMENT

- A. Unless specifically identified for reuse, no used electrical equipment, conduit, conductors, components of any sort scheduled for demolition, disposal or salvage shall be installed for reuse on the project.
- B. Electrical equipment identified specifically as being reused on the project shall be cleaned and protected until such time as it is reinstalled.

3.6 SCHEDULES

- A. Salvage the following equipment to the OWNER at a location they identify. Coordinate the delivery of the salvaged items to the location identified by the OWNER at a time they have pre-approved.
 - 1. None.
- B. Dispose of the following equipment and its associated components.
 - 1. All items called out to be demolished on the Drawings except those specifically listed on the Drawings or in this Section as being salvaged or reused.
- C. Reuse the following items.
 - 1. None.

END OF SECTION

SECTION 16121

600 VOLT CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. The section includes the requirements for conductors and cables used to conduct potentials of 600 volts and less.
 - 2. All conductors and cables shall be installed in conduit or approved raceways regardless of which Division the conductors or cables are specified.

1.2 REFERENCES

- A. The following is a list of Standards which may be referenced in the Section.
 - 1. American Society for Testing and Materials (ASTM).
 - a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
 - 2. National Electrical Contractors Association, Inc. (NECA): National Electrical Installation Standards (NEIS).
 - 3. National Electrical Manufacturers Association (NEMA).
 - a. WC 3, Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - b. WC 5, Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - c. WC 7, Cross Linked-Thermosetting Polyethylene Wire and Cable for the Transmission and Distribution of Electrical Energy.
 - d. WC 55, Instrumentation Cables and Thermocouple Wire.
 - 4. National Fire Protection Association (NFPA). 70, National Electrical Code (NEC).
 - 5. Underwriters Laboratories, Inc. (UL).
 - a. 13, Standard for Power-Limited Circuit Cables.
 - b. 44, Standard for Safety Rubber-Insulated Wires and Cables.
 - c. 62, Standard for Safety Flexible Cord and Fixture Wire.
 - d. 510, Standard for Safety Insulating Tape.
 - e. 854, Standard for Safety Service-Entrance Cables.
 - f. 910, Standard for Safety Test Method for Fire and Smoke Characteristics of Electrical and Optical Fiber Cables Used in Air Handling Spaces.
 - g. 1277, Standard for Safety Electrical Power and Control Tray Cables.
 - h. 1581, Standard for Safety References for Electrical Wires, Cables and Flexible Cords.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16121.C01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data.

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, weight, and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

A. Single Conductors (16121.C01).

1. Conductors shall be rated for 600 volts and conform to applicable requirements of NEMA.
2. Conductors shall be stranded copper.
3. Insulation type shall be THWN-2 or THHN.
4. Conductors shall be sized per the Drawings and the NEC, whichever is greater.
5. Rome Cable Corporation, Southwire Company, Okonite Company, or approved equal.

2.2 ACCESSORIES

A. Colored Tape (16121.T01).

1. Colored tape shall be used to identify individual conductors larger than # 6 AWG.
2. 3M colored tape, or approved equal.

B. Cable Ties (16121.T05).

1. Cable ties shall be nylon, adjustable, self-locking, and properly sized for the bundle and force implied.
2. Thomas and Betts, Panduit, or approved equal.

C. Pulling Compound (16121.P01).

1. Pulling compound shall be non-corrosive, noncombustible, nonflammable waxed based lubricant listed for this use.

2. Ideal Company, Polywater, Inc., or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Conductor and cable installations shall meet or exceed the NECA National Electrical Installation Standards.
3. Twisted Shielded Pair (TSP) cable installation and termination methods are specified in Section 13410 Basic Measurement and Control Instrumentation Materials and Methods
4. CONTRACTOR shall not exceed the manufacturer's recommendations for maximum pulling tensions or minimum bending radii for respective conductors or cables.
5. Pulling compound is recommended for all conductor or cable installations and shall be used on all installations requiring a mechanical pulling device.
6. Immediately after pulling in conductors or cables, the pulling compound shall be completely removed from the conductors or cables, from boxes, enclosures, floors, walls, etc.
7. Conductor and cable installations shall be continuous without splices or intermediate terminations unless specifically identified on the Drawings or prior written approval from the ENGINEER.
8. Where conductors or cables are routed in boxes enclosures they shall be neatly bundled with cable ties at intervals not to exceed 12 inches on center. The tension for the cable ties shall be set with a tool specifically manufactured for that purpose and of the same manufacturer as the cable tie. Side cutters, linemen pliers and similar tools shall not be used to cut the tail end of the cable tie. The CONTRACTOR shall only use the tool specifically manufactured for this purpose and of the same manufacturer as the cable tie.
9. Conductors and cables shall not be installed until the raceway, boxes, enclosures, conduit bushings, etc. have all been installed. Where conductors or cables have been installed prior to meeting this requirement, the ENGINEER shall at their discretion elect to have the conductors or cables removed, disposed of and replaced with new product.
10. Should the outer jacket of any conductor or cable be damaged in any way, they shall be removed, disposed of and replaced with new product.
11. An equipment grounding conductor shall be installed in all raceways. Size shall be as identified on the Drawings or the NEC, whichever is greater, but in no case shall it be less than # 16 AWG for under 50 volts and no less than # 14 for 50 volts or above.

END OF SECTION

SECTION 16131

CONDUIT AND FITTINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. The Section includes the requirements pertaining to conduits and fittings used to contain electrical conductors and cables.
2. All conductors and cables shall be installed in conduit or approved raceways regardless of which Division the conductors or cables are specified.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section.

1. American National Standards Institute (ANSI).
 - a. C80.1, Rigid Steel Conduit-Zinc Coated.
2. American Society for Testing Materials (ASTM).
 - a. A123 E1, Standard Specification for Zinc-Coated (Galvanized) Coatings on Iron and Steel Products.
3. National Electrical Contractors Association (NECA).
 - a. National Electrical Installation Standards (NEIS).
4. Nation Fire Protection Association (NFPA).
 - a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL).
 - a. 360, Standard for Safety Liquid-Tight Flexible Metallic Conduit.
 - b. 797, Standard for Safety Electrical Metallic Conduit.

1.3 SUBMITTALS

- ###### A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16131.C01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly

identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product data

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

A. Liquid-Tight Flexible Aluminum Conduit (LFAC) (16131.C20).

1. Shall be constructed of a flexible aluminum core with a sunlight resistant thermoplastic outer jacket.
2. Conduit fittings shall be manufactured to the PVC-GRC fitting specifications. Galvanized or non-metallic conduit fittings are unacceptable unless written approval is obtained from the ENGINEER for specific locations before installation.
3. No couplings shall be installed.
4. Sealing rings shall be installed where conduit terminates at an enclosure.
5. Conduit shall be Anaconda, Electriflex, T & B, or approved equal.
6. Sealing ring shall be OZ Gedney 4Q-G, or approved equal.

B. Rigid Non-metallic Conduit (PVC) (16131.C30).

1. Shall be schedule 40 PVC unless specifically called out otherwise on the Drawings.
2. Shall be sunlight resistant.
3. Shall be manufactured in accordance with UL-651 Standard.
4. Conduit and fittings shall be securely glued.
5. Provide conduit bell ends at vaults unless specifically called out otherwise on the Drawings.
6. Provide PW Pipe, Carlon, or approved equal.

C. EMT Conduit (16131.C50).

1. EMT conduit may be used in all indoor and outdoor locations. In all locations the fittings shall be watertight compression fittings. Set screw fittings shall be unacceptable in all locations.
2. Conduit connectors shall have insulated throats, plastic bushings or ground bushing installed.
3. Conduit fittings shall be hot dipped galvanized malleable iron.
4. Condulets shall be form 5 malleable iron type.

2.2 ACCESSORIES

A. Conduit Thread Lubricant (16131.L01).

1. Shall be an electrically conductive with copper particles suspended in the product.
2. Provide Kopr-Shield Catalog number CP8-TB, or approved equal.

B. Glue (16131.G01).

1. Glue shall be the wet/dry rated cement commonly referred to as “Blue Glue”.

C. Cord Connector (16131.C90).

1. Provide stainless steel cord grip with integrated stainless steel mesh.
2. Provide Hubbell SCH1000 Series, or approved equal.
3. Provide cord grip with stainless steel integrated mesh for any unsupported cord longer than 59 inches to provide adequate support of the cord.

D. Conduit System Drain (16131.D33).

1. Provide a conduit system drain designed specifically for the purpose of draining accumulated condensate and to provide ventilation designed to minimize condensation.
2. The device shall UL Standard 514B certified.
3. The bodies and locknut shall be copper-free aluminum construction. The device shall be supplied with a stainless steel screen which may be removed and cleaned as required.
4. Provide a Cooper Crouse-Hinds 0.75 inch drain catalog number CD2-SA, or approved equal.

E. Cord Grip (CGB) (16131.C89).

1. Provide stainless steel bodied cord grips with NPT mounted in conduit couplings as identified on the Drawings.
2. Provide Hubbell, Kellems, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General Requirements

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification
2. Install conduit runs in accordance with the schematic representation shown on the Drawings.
3. Provide conduit drains installed as shown on the Drawing details and in conduit systems as identified on the Drawings.
4. Discuss the installation details with the ENGINEER before underground conduits are covered. Changes that may become necessary in the conduit system resulting from a lack of coordination with the ENGINEER prior to covering underground conduits shall be completed by the CONTRACTOR at no additional expense to the OWNER.
5. Minimum conduit size shall be .75 inch unless specifically called out otherwise on the drawings.
6. Where raceways are indicated, but the routing is not identified, the routing shall be the CONTRACTOR’S choice and in accordance with the rest of the Contract Documents and the National Electrical Code (NEC).

7. Raceways shall be electrically and mechanically complete before the conductors are installed.
8. Routing of conduits may be adjusted to avoid obstructions. Coordinate with other trades prior to installation of raceways. Lack of such coordination shall not be justification for extra compensation and removal and reinstallation to resolve conflicts shall be at the CONTRACTOR's expense.
9. Conduit joints shall be wrench tight, thoroughly grounded, secure and free of obstructions.
10. Conduits shall be reamed.
11. Exposed conduits shall be installed parallel or perpendicular to the structural members and surfaces and shall be level and or plumb.
12. When two or more conduits are routed in the same general direction their routing shall be parallel with symmetrical bends.
13. Conduits shall be bent with equipment specifically designed for this purpose and for the specific size and type of conduit.
14. Conduits that are creased or crushed shall be replaced.
15. Install conduits such that they do not interfere with the proper and safe operation of equipment and do not block or otherwise interfere with the ingress and egress and installation of removable hatches and covers.
16. Install expansion joints as needed across expansion joints in the structure and at other locations where necessary to compensate for thermal or mechanical expansion or contraction.
17. Conduits shall be routed at least six (6) inches from high temperature piping, ducts and flues.
18. Final connections to dry type transformers, motors, instruments and other equipment requiring a flexible connection shall be made with LFAC conduit. Lengths shall not exceed three (3) feet.
19. All conduits shall be capped throughout construction to prevent entrance of dirt, trash, water, etc.
20. All conduits shall be individually identified at every point they terminate. The conduit identification shall be the same as that which is used on the conduit /conductor schedule in the Drawings. Should conduits be installed that are not listed on the conduit schedules, the CONTRACTOR shall add conduit callouts to the as-built conduit schedules and label the conduits accordingly.

B. Underground Conduit Installation.

1. Underground conduits shall be PVC except as specifically noted differently elsewhere.
2. Conduits routed under a concrete slab shall be routed under the vapor barrier. The conduits shall be routed deep enough so the radius of the conduit stubbed up through the slab is completely below grade. The vapor barrier shall be sealed at every point a conduit penetrates the barrier as per the requirements specified for the vapor barrier.
3. Underground conduits shall be routed as shown on the Drawings.
4. Power conduits shall be separated from all other conduits by a minimum of 12 inches and when required to cross other conduits it shall be done at a 90 degree angles.

5. Conduits routed in structural concrete shall be routed in such a manner as to not interfere with the structural integrity of the concrete. The ENGINEER shall approve CONTRACTOR's proposed conduit routing before installation. It is the CONTRACTOR's responsibility to coordinate conduit routing with the ENGINEER well before it is scheduled to be installed. Conduits shall be stubbed up directly under the enclosure or device they will serve. The CONTRACTOR is responsible to coordinate with the other trades prior to installation of raceways. Lack of coordination shall not be justification for extra compensation and removal and re-installation of conduits to resolve conflicts shall be done at the CONTRACTOR's expense.
6. Where conduits are stubbed up out of a concrete floor or slab, the PVC conduit shall extend two (2) inches above finished floor or grade including housekeeping pads before transitioning to any other type of conduit.
7. Underground conduit shall have a minimum of 24 inches of cover unless specifically called out differently on the Drawings.

END OF SECTION

SECTION 16135

BOXES AND ENCLOSURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes.

1. This Section includes requirements for electrical device boxes, enclosures, in-ground boxes and vaults.

1.2 REFERENCES

A. The following is a list of Standards that may be referenced in the Section.

1. American Society for Testing and Materials (ASTM).
 - a. A123 E1 Standard Specifications for Zinc-Coated Coatings on Iron and Steel Products.
2. National Electrical Contractors Association, Inc. (NECA).
 - a. 5055 National Electrical Installation Standard.
3. National Fire Protection Association (NFPA).
 - a. 70 National Electrical Code (NEC)
4. Underwriters Laboratory, Inc. (UL).
 - a. 514C Standard for Safety Non-Metallic Outlet Boxes, Flush Device Boxes and Covers.
 - b. 50 Enclosures for Electrical Equipment.

1.3 SUBMITTALS

A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.

1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16135.B01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B.

C. Product Data.

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, equipment weight and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 DEVICE BOXES

A. **Cast Iron Boxes (16135.B01).**

1. Shall be cast iron galvanized boxes, have tapered threaded hubs and be the deep FD type in all cases.
2. Boxes shall have internal grounding screw.
3. Shall have external mounting tabs.
4. Whichever manufacturer is submitted and approved, all like boxes on Project shall be of the same manufacturer.
5. Provide OZ Gedney, Crouse-Hinds, or approved equal.

B. **Medium In-Ground Pull Box (16135.L01).**

1. Box and lid combo shall be ANSI/SCTE Tier 22 Heavy Duty rated.
2. Shall be 25" x 15-1/2" polymer concrete body.
3. Depth shall be 12".
4. Solid polymer lid, skid resistant.
5. Penta Head stainless steel bolts and hardware.
6. Old Castle 1324, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Install boxes and enclosures in accordance with the schematic representation as indicated on the Drawings.
3. Boxes and enclosures shall be mounted level and plumb.
4. Boxes and enclosures shall not be altered, holes drilled, etc. in any way that may compromise the NEMA rating of the enclosure or box.
5. Boxes and enclosures shall be mounted with stainless steel hardware.
6. Boxes and enclosures shall be bonded the equipment grounding conductor.
7. Surface mounted enclosures and boxes shall be spaced off the surface at least 1/4 inch in damp or wet locations.
8. Boxes and enclosures with threaded hubs or punched holes shall have the opening match the conduit size. The use of reducing bushings or reducing washers is unacceptable.

9. Enclosures shall be provided whenever a junction or pull box larger than 4 inches square is required.
10. Sheet metal boxes are not approved for this Project.

END OF SECTION

SECTION 16150
WIRING CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
1. This Section includes requirements for conductor termination methods.
 2. Additional conductor termination means and methods are specified in Sections 13410 Basic Measurement and Control Instrumentation Materials and Methods.

1.2 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16150.C01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
- B. Product Data.
1. Provide product data on all components specified.
 2. Manufacturer's data including materials of construction, applications and related information for each item specified in PART 2 PRODUCTS.

PART 2 PRODUCTS

2.1 MATERIALS

- A. **Small Compression Connectors (16150.C01).**
1. Insulated fork, ring or splicing (butt) connectors shall be provided for # 10 AWG or smaller conductors that splice together or terminate with a screw other than in a terminal block.
 2. Connectors shall be properly sized for the conductor and for the stud used.

3. Burndy, Panduit, Thomas and Betts, or approved equal.

B. Electrical Spring Connectors (Wire Nuts) (16150.W01).

1. Provide properly sized spring connectors for the size and number of conductors spliced.
2. Ideal, 3M, Thomas and Betts, or approved equal.

2.2 ACCESSORIES

A. Electrical Tape (16150.T40).

1. General electrical tape shall be premium grade, all weather vinyl electrical insulating tape.
2. 3M – Scotch 33+, or approved equal.

B. Thin Wall Heat Shrink Tubing (16150.T01).

1. Thin walled heat shrink tubing shall be flame retardant and made of cross-linked polyolefin.
2. The tubing shall have a minimum operating temperature of – 55 to + 135 degrees Celsius.
3. Burndy, Panduit, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Care shall be taken when terminating conductors to avoid kinking, cutting or puncturing the jacket or allowing contamination by grease, oil or water.
3. Care shall be taken when terminating conductors to properly support the conductors and to avoid undue pressure on the connector or utilization equipment.
4. Conductors shall be terminated by use of lugs, pressure type connectors wire nuts or terminal blocks. Wrapping conductors around a screw type terminal is not acceptable.
5. Compression connectors shall be installed using the tool and die provided by the same manufacturer as the connectors and as per their directions.
6. Compressions on connectors used for # 8 AWG conductors and larger shall have a minimum of two (2) circumferential crimps.
7. Indenter type crimps on compression connectors shall not be used on conductors larger than # 10 AWG.
8. Additional conductor termination means and methods including terminal blocks and control conductors are specified in Sections 13410 Basic Measurement and Control Instrumentation Materials and Methods and Section 13430 Boxes, Control Panels and Control Centers.
9. Connectors shall be installed as per the manufacturer's directions.

10. Insulated wire ferrules shall be provided for conductors terminated on terminal blocks utilizing a crimping tool provided by the ferrule manufacture specifically for this purpose.
11. Where wire ducts in enclosures exist, conductors shall be grouped together and routed in the wire ducts and shall be fanned out to the terminals.
12. Wire nuts shall be used on conductors # 10 AWG or less and only for splicing conductors at light fixtures, at receptacles and motors. No other splicing of conductors with wire nuts are permitted unless specifically identified on the Drawings.
13. All spare conductors shall be identified individually, neatly coiled and fastened with cable ties. The coil shall be labeled to describe its origin. Spare conductors shall be left long enough to be neatly routed and terminate anywhere within the enclosure.
14. Thin wall heat shrink tubing shall be installed over twisted shielded pair cable where the cable is stripped back. Reference Section 13410 Basic Measurement and Control Instrumentation Materials and Methods for specifics on this installation.
15. As connections are set with a torque wrench, a black felt marker shall be used to mark across the bolt, nut or screw indicating the torque has been set.

END OF SECTION

SECTION 16410

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes the following enclosed low voltage components rated at 600 VAC or less:
 - 1. Heavy duty single throw, fused, safety switch.

1.2 REFERENCES

- A. National Fire and Protection Association (NFPA)
 - 1. 70 - National Electrical Code (NEC)
- B. National Electrical Manufacturers Association (NEMA).
 - 1. B 3-2001 - Molded Case Circuit Breakers and Their Application.
 - 2. AB 4-2001 - Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
 - 3. KS 1-2001 - Enclosed and Miscellaneous distribution Equipment Switches (600 Volts Maximum).

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
 - 1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
 - 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16410.S21) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 - 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.
- B. Product Data
 - 1. Provide product data on all components specified.
 - 2. Manufacturer's data including materials of construction, equipment weight, and related information for each item specified in PART 2 PRODUCTS.

C. Shop Drawings

1. Back panel and enclosure layouts including interior and exterior front and side exterior view details showing maximum overall dimensions.
2. For enclosure weighing 150 pounds and over, provide physical properties, handling and mounting data including total weight, lifting instructions, height, and floor space required. Mounting requirements for seismic zone 4.
3. All drawings shall list the equipment number.
4. Component designations, shall match those shown on the Drawings.

D. Quality Assurance/Control Submittals

1. Manufacturer's Instructions
 - a. List special requirements or restrictions of the motor/load combination.
 - b. Submit copy of the manufacturer's operating and maintenance manuals and, installation instructions.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements

1. Products shall be UL listed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection

1. Products shall be stored and installed in a dry environment maintained at 65 degrees F or above.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. **Heavy Duty Safety Switch (16410.S21).**

1. Heavy duty safety switches shall be provided as shown on the Drawings
2. Heavy duty safety switches shall be rated for the load served and shall switch all the phase conductors.
3. Heavy duty safety switches shall include separate, unswitched, neutral and ground buses where applicable.
4. Heavy duty safety switch enclosures shall be painted steel, NEMA 3R, outdoor, surface mount for outdoor installations and NEMA 12 surface mount for indoor installations
5. Heavy duty safety switch ground bus shall be large enough to accommodate terminations for all grounding conductors.
6. Provide Hubbell HBL13R23D, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
- B. Install switches and circuit breakers as indicated on the Drawings.
- C. Install equipment level and plumb.
- D. Provide nameplates as indicated on the Drawings.

3.2 ADJUSTING

- A. Adjustable features such as the trip setting for a circuit breaker shall be adjusted pursuant to the manufacturer's instructions.

END OF SECTION

SECTION 16440

PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes.
 - 1. This Section includes the requirements for panelboards.

1.2 REFERENCES

- A. The following is a list of Standards which may be referenced in this Section.
 - 1. National Fire Protection Association (NFPA).
 - a. 70 – National Electrical Code (NEC).
 - 2. National Electrical Contractors Association (NECA).
 - a. 5055 - National Electrical Installation Standards (NEIS).
 - 3. National Electrical Manufacturers Association (NEMA).
 - a. AB 1 – Molded Case Circuit Breakers.
 - b. KS 1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 volts maximum).
 - c. PB 1 – Panelboards
 - d. PB 1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
 - 4. International Electrical Testing Association (NETA).
 - a. Acceptance Testing Specifications.
 - 5. Underwriters Laboratory, Inc. (UL).
 - a. 50 – Enclosures for Electrical Equipment.
 - b. 67 – Panelboards.
 - c. 489 – Molded Case Circuit Breakers and Circuit Breaker Enclosures.

1.3 SUBMITTALS

- A. Contractor shall submit all the product data in Division 16 at the same time. Piecemeal submittals will be rejected as incomplete.
 - 1. The product data shall be bound in a three ring binder with tabs for each Section. The tabs shall be numbered to match the specification Section numbers. Submittals not bound and labeled as specified will be rejected as incomplete.
 - 2. A submittal is required for each product specified. Each individual product submittal shall have the corresponding Reference Keynote Number (example - 16440.P01) typewritten in the upper right hand corner of the submittal. The submittals within each Section tab shall be in the same sequential order as they are listed in the specification Section. Submittals not containing the Reference Keynote Number will be rejected as incomplete.
 - 3. No typical submittals will be accepted. Each submittal shall be project specific and clearly identify specifically which components or parts are being submitted for

approval. Any product submittals, such as a catalog sheet, which do not clearly identify which components or parts are being submitted for approval, will be rejected as incomplete.

B. Product Data.

1. Provide product data on all components specified.
2. Manufacturer's data including materials of construction, equipment dimensions, weight and related information for each item specified in PART 2 PRODUCTS.

1.4 QUALITY ASSURANCE

- A. Panelboards shall be manufactured in accordance with the Standards listed under 1.2 REFERENCES.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be stored and installed in clean, dry and heated environment.

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. **Panelboard (16440.P01).**

1. Shall be rated for the voltage, phases and amperage as indicated on the Drawings.
2. Provide main circuit breaker, main lugs or feed through lugs as shown on the Drawings.
3. Shall have a NEMA 3R enclosure, painted gray and surface mount unless shown otherwise on the Drawings. Enclosure shall not have pre-punched conduit knockouts.
4. Front cover shall be provided with a door within a door configuration with continuous hinged doors that are lockable for both the inner access and the front door providing access to the circuit breakers. The dead front shall be attached to the access door such that when opened the dead front swings open with the door.
5. Main breaker shall have an available in-rush current (AIC) rating as shown on the Drawings. Branch circuit breakers shall have the same rating unless specifically shown otherwise on the Drawings.
6. Main breaker shall be thermal, adjustable magnetic trip.
7. Branch circuit breaker capacity shall be as shown on the Drawings. Provide branch circuit breakers as shown on the Drawings.
8. Bus material shall be 100 % copper rated for the voltage and ampere rating shown on the Drawings as a minimum.
9. Grounded conductor connection means shall be isolated, copper.
10. Grounding conductor connection means shall be copper.
11. Breakers shall be bolt-on type. No half sized breakers shall be permitted.
12. Provide factory installed lockable disconnecting means that meets the requirements of the National Electrical Code (NEC) Article 110-25 on every circuit breaker.
13. See the panel schedule on the Drawings for additional data.

14. All panelboards and main breaker disconnects on the project shall be of the same manufacturer.
15. Provide arc flash labels compliant with the NEC, OESC and OSHA.
16. Provide integral, factory installed TVSS, IEEE C62.41 certified, 250kA per phase surge rating or higher. Coordinate voltage to match panel. Provide Eaton type CPS, or approved equal.
17. Provide Eaton Series Pow-R-Line, or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. General.

1. All identification labeling shall be in compliance with Section 16075 Electrical and Control Identification.
2. Panels shall be grounded and bonded as shown on the Drawings and per the NEC whichever is more stringent.
3. Conductors shall be neatly grouped and routed within the enclosures.
4. Used and spare conductors shall be clearly identified as specified in Section 16121.
5. Due to the number of conduits entering the panelboards it will be imperative that the CONTRACTOR plan the layout carefully so all the conduits fit in the bottom of the panelboards. Should a gutter be necessary, it shall be no deeper than the panelboards and only as wide as necessary to accommodate the conduits.
6. Provide typed circuit directory for each panelboard.

END OF SECTION