

DIVISION 16

ELECTRICAL

INDEX

| <u>Section</u> | <u>Title</u>                  |
|----------------|-------------------------------|
| 16050          | Electrical General Conditions |
| 16060          | Grounding Systems             |
| 16080          | Underground Systems           |
| 16085          | Miscellaneous Equipment       |
| 16120          | Wire and Cables               |
| 16130          | Raceways and Fittings         |
| 16442          | Panelboards                   |
| 16500          | Lighting System               |

[This Page Intentionally Left Blank]

## SECTION 16050

### ELECTRICAL GENERAL CONDITIONS

#### PART 1 – GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

##### 1.2 SUMMARY OF WORK

- A. The work covered under this Section of the Specifications includes the following:

1. 16060 – GROUNDING SYSTEMS
2. 16080 – UNDERGROUND SYSTEMS
3. 16085 – MISCELLANEOUS EQUIPMENT
4. 16120 – WIRE AND CABLES
5. 16130 – RACEWAYS AND FITTINGS
6. 16442 – PANELBOARDS
7. 16500 – LIGHTING SYSTEM

- B. Related Sections include the following:

1. Division 0 – Bidding and Contract Requirements
2. Division 1 – General Requirements

- C. Work included:

1. All labor, materials, tools, equipment, and accessory items and performing all operations necessary to furnish and install the complete electrical work in accordance with this section of these specifications, the drawings and the standards of the applicable codes listed herein.
2. Furnishing and installation of equipment and items listed below and installation only of items furnished under other sections of these specifications.
  - i. Complete electrical service as hereinafter specified.
  - ii. Conduit, wire and electrical connections are required on certain items specified in sections of these specifications other than the electrical section. The Electrical Contractor shall examine all sections of these specifications to determine the complete scope of the electrical work.

#### GENERAL ELECTRICAL CONDITIONS

- iii. Raceways and fittings
  - iv. Wires and cables
  - v. Miscellaneous equipment
  - vi. Panelboards
  - vii. Automatic transfer switch
  - viii. Grounding systems
  - ix. Lighting systems
  - x. Electrical demolition
- 3. Mount and make all field connections to process instrument panels and other control panels furnished under other Divisions of these Specifications.
  - 4. Mount and wire process instruments and equipment furnished under other Divisions of these Specifications. Furnish and install all conduit, wire and interconnections between process instrumentation primary elements, transmitters, local indicators and receivers. Mount and wire all lightning and surge protection equipment at process instrumentation transmitters and receivers.
  - 5. Make field connections to “packaged” equipment furnished under other Divisions of these Specifications.

D. Work not included:

- 1. Excavation and backfilling, including gravel or sand bedding for underground electrical work is included under DIVISION 2 - SITE WORK of these Specifications.
- 2. Concrete work, including concrete electrical duct encasement, mounting pads, and housekeeping pads, is included under DIVISION 3 - CONCRETE of these Specifications.

1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of the SECTION 00700, GENERAL CONDITIONS.
- B. Submittals required under this section include, but are not limited to the following:
  - 1. Panelboards
  - 2. Lighting fixtures
  - 3. Disconnect switches
  - 4. Miscellaneous equipment
  - 5. Wire
  - 6. Conduit

7. Receptacles
  8. Boxes and fittings
  9. Grounding System
- C. Submit all other data as specified herein.
- D. "As-built" copies of all shop drawings shall be submitted to the Engineer before final inspection and acceptance.
- E. The responsibility for all dimensions to be confirmed and correlated at the job site and for coordination of this work with the work of all other trades is also included under the work of this SECTION 16050, ELECTRICAL GENERAL CONDITIONS.
- F. No material shall be ordered or shop work started until the Engineer's approval of shop drawings has been given.
- G. Prior to submitting shop drawings for lighting fixtures, verify the type of ceiling being installed. Notify Engineer of any discrepancies between fixture type specified and ceiling system. Additional cost rising from failure to notify the Engineer will be the responsibility of the Electrical Contractor.

#### 1.4 QUALITY ASSURANCE

- A. Requirements of the Regulatory Agencies
1. The final, complete installation shall comply with all state and local statutory requirements having jurisdiction. The Electrical Contractor shall arrange for all necessary permits, pay all fees and arrange for all required inspections by local authorities. In general, all work shall comply with the requirements of the National Electrical Code, all state codes and the codes and ordinances of the city or town in which the work is to be done.
- B. Materials and equipment used shall be Underwriters Laboratories, Inc. listed wherever standards have been established by that agency. Written approval by the Engineer and local inspecting authority is required wherever UL Listed approval is not available.
- C. Manufacturer of Principal Equipment
1. All lighting and power panelboards shall be made by one manufacturer
  2. All motor controls furnished under this Section shall be made by one manufacturer.
  3. All conduit of a given type shall be made by one manufacturer.
  4. All wire and cables of a given type shall be made by one manufacturer.

#### D. Tests and Settings

1. Test all systems furnished under DIVISION 16 - ELECTRICAL and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the system.
2. Make all circuit breaker and motor circuit protector settings.
3. The following minimum tests and checks shall be made prior to the energizing of electrical equipment. A certified test report shall be submitted stating that the equipment meets and operates in accordance with manufacturer's and job specifications, and that equipment and installation conforms to all applicable standards and specifications.
  - i. Testing of static devices, circuit breakers and motor circuit protectors for calibration and proper operation and settings.
  - ii. Over potential, high potential, insulation resistance and shield continuity tests for cables.
  - iii. Mechanical inspection of air interrupter switches and circuit breakers.
4. The Engineer shall be immediately notified of any unfavorable test results or indication of faulty equipment. No piece of equipment shall be energized until the test data is evaluated and the equipment is proven acceptable.
5. If the test and inspection data submitted should indicate deficiencies in the operation of the electrical apparatus or in the manufacturer thereof, the Electrical Contractor shall promptly implement the necessary adjustments, corrections, modifications and/or replacements necessary to be made to meet the specified requirements.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance.
- B. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored out-of-doors. Electrical equipment shall be stored in dry permanent shelters. If stored for more than two weeks, the equipment shall receive all maintenance considerations required by the manufacturer for the proper storage of equipment. Proper storage in this context shall include the provision of heaters and dehumidifiers to keep the equipment dry at all times. If any apparatus has been damaged, such damage shall be repaired at no additional cost to the Owner. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and put through such special tests as directed by the Engineer, or shall be replaced at no additional cost to the Owner.

## 1.6 COORDINATION

- A. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow speedy and efficient completion of the work.
- B. Furnish to other trades advance information on locations and sizes of all frames, boxes, sleeves and openings needed for their work, and also furnish information and shop drawings necessary to permit trades affected by the work to install same properly and without delay.
- C. In all spaces, prior to installation of visible material and equipment, including access panels, review all contract Drawings for exact locations and where not definitely indicated, request information. Where the electrical work shall interfere with the work of other trades, assist in working out the space conditions to make satisfactory adjustments before installation. Without extra cost to the Owners, make reasonable modifications to the work as required by normal structural interferences. Maintain maximum headroom at all locations. All conduit, and associated components to be as tight to underside of structure as possible.
- D. If any electrical work has been installed before coordination with other trades so as to cause interference with the work of such trades, all necessary adjustments and corrections shall be made by the electrical trades involved without extra cost to the owners.
- E. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution for review and approval.
- F. Protect all materials and work of other trades from damage which may be caused by the electrical work, and repair all damages without extra cost to the owner.

## 1.7 CUTTING AND PATCHING

- A. All openings required by the work of these Sections shall be planned for in advance. Any cutting and patching required by the lack of such planning shall be done by the General Contractor at the expense of this Electrical Contractor. It will be the responsibility of this Electrical Contractor to keep the General Contractor informed of all required openings.

## 1.8 SIZE OF EQUIPMENT

- A. In general, indicated equipment sizes and layout is based on standard electrical equipment by Eaton, electrical equipment by General Electric, Square D, and Siemens with similar dimensions is acceptable. The Electrical Contractor shall be responsible for coordinating the equipment layouts with the electrical equipment being supplied.
- B. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the structure.

- C. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitable, to insure that the tilting does not impair the functional integrity of the equipment.

#### 1.9 SUPPLEMENTARY SUPPORTING STEEL

- A. Provide all supplementary steelwork required for mounting or supporting equipment and materials.
- B. Steelwork shall be firmly connected to building construction as required.
- C. Steelwork shall be of sufficient strength to allow only minimum deflection in conformity with manufacturer's published requirements.
- D. All supplementary steelwork shall be installed in a neat and workmanlike manner parallel to floor, wall and ceiling construction; all turns shall be made at forty-five and ninety degrees, and/or as dictated by construction and installation conditions.
- E. All manufactured steel parts and fittings shall be galvanized steel for NEMA 12 Areas and stainless steel for NEMA 4X and NEMA 7 areas.

#### 1.10 DESIGN CRITERIA

##### A. Service Characteristics

1. Secondary Voltage - High Level: N/A
2. Secondary Voltage - Low Level: 120/240V
3. All equipment and wiring shall be suitable for the applied voltage.

##### B. Service and Metering

1. The power company serving this project is Eversource.
2. A new service will be obtained at 120/240Volts, 1-phase, 3-wire from existing utility transformer on an existing utility pole. Coordinate with Eversource for pole light relocation and removal of the existing utility pole as indicated on the contract drawings.
3. Furnish and install the secondary service conduit, wire and connectors
4. Eversource will provide the meter. The Electrical Contractor shall provide the meter socket and install all the metering equipment in accordance to the utility company requirements.
5. All Work and material for the electrical service shall be in accordance with the requirements of Eversource.



6. Make all arrangements with the Eversource for obtaining the pump station's new services and furnish all labor and material for the service. Submit any utility fee invoice(s) associated with the service replacement to the Owner. The Owner shall make direct payment(s) for the fee(s) to Eversource.
- C. ELECTRICAL HAZZARDOUS CLASSIFCATION AND NEMA RATINGS FOR ELECTRICAL INSTALATION AND ENCLOSURES
1. Unclassified, NEMA Type 12 for within electrical enclosure.
  2. Unclassified, NEMA Type 4X for exterior.
  3. Class 1, Division I, NEMA Type 8 for within and 18" above the Wet Well.

#### 1.11 INTERPRETATION OF DRAWINGS

- A. Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.
- B. The Drawings are not intended to show exact routing of conduit runs or terminations. Electrical Contractor shall determine exact location of conduit terminations by examinations of approved shop drawings. The Electrical Contractor shall not reduce the size or number of conduit runs indicated on the drawings.
- C. Locate pull boxes, panelboards, control panles, terminal cabinets, safety switches and such other apparatus as may require periodic maintenance, operation, or inspection, so that they are easily accessible. If such items are shown on the drawings in locations which are found to be inaccessible, advise the Engineer of the situation before work is advanced to the point where extra costs will be involved.
- D. Each feeder circuit shall be run in a separate conduit unless otherwise shown on the drawings.
- E. Unless otherwise approved by the Engineer conduits shown exposed shall be installed exposed; conduits shown concealed shall be installed concealed.
- F. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation.
- G. In general, wiring and raceway systems for lighting, receptacles, and branch circuiting are not indicated on the drawings but shall be furnished and installed under this section.
- H. Each branch circuit shall have its own neutral, dedicated to that circuit. A common neutral for more than one single phase circuit is not allowed.
- I. Any work installed contrary to drawings shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

- J. The locations of equipment, fixtures, outlets, and similar devices shown on the drawings are approximate only. Exact locations shall be determined by actual construction conditions, major deviations from locations shall be approved by the engineer. Obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.
- K. Circuits on panelboards shall be field connected to result in evenly balanced loads on each phase or leg.
- L. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical system shown. Additional circuits shall be wherever needed to conform to the specific requirements of the equipment.
- M. All connections to equipment shall be made as required, and in accordance with the approved shop and setting drawings.
- N. Schematic diagrams shown on the drawings indicate the required functions only. Standard circuits of the particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic drawings shown. Additional wiring or conduit required for such deviations shall be furnished at the Electrical Contractor expense. The Electrical Contractor must ensure that all components necessary to accomplish the required function are provided.

#### 1.12 TEMPORARY POWER AND LIGHTING

- A. Furnish and install feeders of sufficient size from the utility company for the electric light and power requirements including by-pass pumping equipment and the existing SCADA control panel for the project while under construction and until the permanent feeders and related equipment have been installed and are in operation. Temporary lighting shall be based on a minimum of one watt per square foot covering each and every square foot in the project area. Sufficient wiring, lamps, and outlets shall be installed to insure proper lighting in all rooms, space, and stairwells. Minimum sized lamp used shall be 1500 lumens. Where higher lighting intensities are required by Federal or State Standards of Laws or otherwise specified, the above specified lumens shall be increased to provide these increased intensities.
- B. All necessary transformers, meters, cables, panelboards, switches, temporary lamp replacements and accessories required for the temporary light and power installation shall be provided by the Electrical Contractor.
- C. Provide and maintain the work area, a feeder or feeders of sufficient capacity for the requirements of the area and provide a sufficient number of outlets, located at convenient points, so that extension cords of not over 50 ft. in length will reach all work requiring temporary light or power.

- D. All temporary electrical work shall meet the requirements of the National Electrical Code Article 305 Temporary Wiring, the Local Utility Company, and all Federal Standards and Laws
- E. All temporary wiring and accessories thereto installed shall be removed after their purposes have been served.
- F. The General Contractor will pay for the cost of electric energy consumed by himself and by all of his Subcontractors, unless otherwise indicated.
- G. Provide all temporary lighting and power required above during the normal working hours of the project or a total of ten (10) hours per normal working day; Saturdays, Sundays and legal holidays are excluded. The ten hours per day shall include manning the temporary power and lighting 2 hour before and 2 hour after a normal eight (8) hour working day. In addition to the above, provide and maintain, to the satisfaction of the local authorities having jurisdiction, all temporary lighting and power that may be required for safety purposes. The Electrical Contractor will be compensated by the General Contractor for any additional standby time, materials or equipment required by the General Contractor or other Subcontractors beyond the normal working hours, as defined above.

## PART 2 – PRODUCTS - NOT APPLICABLE

## PART 3 – EXECUTION

### 3.1 CORING

- A. Provide all coring for conduits penetrating floors, walls, partitions etc.
- B. Provide waterproof sealing for the penetrations through exterior walls, etc.
- C. Foam type water proofing is not allowed.

### 3.2 MANUFACTURER'S SERVICES

- A. Provide manufacturer's services for testing, training and start-up of the following equipment:
  - 1. Automatic Transfer Switch
- B. The time required for each system shall be as hereinafter specified. The time specified shall be used as directed by the Engineer and shall not be used by the manufacturer or Electrical Contractor for field adjustments due to manufacturing or shipping defects

### 3.3 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700 – Contract Closeout

- B. Operation and Maintenance Manuals - Prepare manuals in accordance with Section 01730.
- C. Record drawings shall be provided by the Electrical Contractor as specified in SECTION 00700 – General Conditions of the Contract and SECTION 01700 – Contact Close Out.
- D. Provide warranty and guarantee on all equipment furnished and work performed for a period of one (1) year from the date of substantial completion.

END OF SECTION 16050

SECTION 16060  
GROUNDING SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY OF WORK

- A. The work covered under this Section of the Specifications includes the furnishing and installing of a complete grounding system in strict accordance with Article 250 of the National Electrical Code and as specified herein and as shown on the drawings.

1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300 – Submittals
- B. Submittals required under this section include, but are not limited to the following:
  - 1. Wire
  - 2. Ground rods

1.4 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance

PART 2 –PRODUCTS

2.1 WIRE

- A. Wire shall be as specified under Section 16120 – Wire and Cables

2.2 GROUND RODS

- A. Ground rods shall be copper clad steel 3/4 inch in diameter and 10 feet in length unless otherwise shown on the drawings. Rods shall be either one 10 foot length or two shorter lengths coupled together by a thermic welding process. Ground rods shall be Copperweld, equal by A.B. Chance Co., or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Grounding electrode conductors shall be run in rigid conduits. Protecting conduits shall be bonded to the grounding electrode conductors at both ends.
- B. Grounding conductors shall be run with feeders where shown on the drawings or hereinafter specified.
- C. Liquid tight flexible metal conduit in sizes 1 inch and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps. Tie wraps shall be installed 12 inches apart and not more than 6 inches from ends.
- D. Connect the following equipment by separate wire or cable directly to the grounding grid system
  - 1. Service entrance meter
  - 2. Service entrance circuit breaker
  - 3. Ground buses
  - 4. Generator Enclosure
- E. Connect the following equipment by separate wire or cable to the equipment's ground bus and or ground terminal:
  - 1. Panelboards
  - 2. Control panels
  - 3. Equipment having feeders and branch circuit installed in non-metallic raceways
  - 4. Receptacle circuits
- F. The following equipment shall be grounded separate wire or cable to the equipment's ground chassis or ground terminal:
  - 1. All metal cases and support frames
  - 2. Lighting system
  - 3. 120 Volt motors
- G. Bond the following N.E.C. approved electrodes together to form a ground grid system:
  - 1. Steel reinforcing rods
  - 2. Grounding rods
  - 3. Buried bare copper conductors

- H. Grounding electrodes shall be driven where shown on the drawings. Spacing between electrodes shall be equal to or greater than the length of the electrodes.
- I. Exposed grounding connections shall be made by means of approved bronze clamps. Exposed connections between different metals shall be sealed with No. Oxide Paint Grade A, or equal.
- J. All grounding connections shall be made by means of approved bronze clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A, or equal.
- K. All buried connections shall be made by a thermic welding process equal to Cadweld. Molds used for the welding process shall be new having no prior usage. Molds shall be the specific type for the connection to be made.
- L. All buried conductors shall be laid slack in trenches. The earth surrounding the cables shall be void of sharp objects which may injure the cables. Backfill material shall be natural earth. Where cables are exposed to mechanical injury they shall be protected by pipes or other substantial guards. If guards are iron pipe or other magnetic material, conductors shall be electrically connected to both ends of the guard. Connections shall be made as hereinbefore specified.

### 3.2 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700 – Contract Closeout

END OF SECTION 16060

## SECTION 16080

### UNDERGROUND SYSTEMS

#### PART 1 – GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

##### 1.2 SUMMARY OF WORK

- A. The work of this section includes furnishing and installing of a complete underground system of raceways as specified herein and as shown on the drawings.

##### 1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300 – Submittals

- B. Submittals required under this section include, but are not limited to the following:

1. Raceways
2. Warning Tape

##### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance

#### PART 2 –PRODUCTS

##### 2.1 RACEWAYS

- A. Raceways shall be PVC schedule 40 conduit. Raceway materials shall be in accordance with Section 16130 – Raceways and Fittings.

##### 2.2 POLYETHYLENE WARNING TAPE

- A. Warning tape shall be red polyethylene film, 6 inch minimum width, Type XB-720 by W.H. Brady Co., or equal.



## PART 3 – EXECUTION

### 3.1 INSTALLATION

- B. The minimum cover for raceway banks shall be 30 inches unless otherwise permitted by the Engineer.
- C. Raceway entrances to structures shall be made with steel conduit not less than three feet long.
- D. Where bends in raceways are required, long radius elbows, sweeps and offsets shall be used. Sweeps at riser pole shall be rigid steel encased in concrete.
- E. All raceways shall be swabbed clean before cable installation.
- F. Spare raceways shall be plugged and sealed watertight at all buildings and structures.
- G. Raceways in use shall be sealed watertight at all structures.
- H. Rigid steel conduit shall be used for risers at the service pole and other locations shown on the drawings. Conduit sweep at pole base shall be rigid steel conduit.
- I. All underground metallic conduit run underground in direct contact with earth shall be coated with asphaltum or bitumastic varnish or similar corrosion protection the entire length of the run.
- J. All underground raceways/ductbanks shall be marked with warning tape located approximately 12 inches below grade above the raceway/ductbank.

### 3.2 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700 – Contract Closeout

END OF SECTION 16080

## SECTION 16085

### MISCELLANEOUS EQUIPOMENT

#### PART 1 – GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

##### 1.2 SUMMARY OF WORK

- A. The work of this section includes the furnishing and installing of all miscellaneous equipment as specified herein and as shown on the drawings.

##### 1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300 – Submittals

- B. Submittals required under this section include, but are not limited to the following:

1. Electrical Enclosure Cabinet
2. Automatic Transfer Switch
3. Manual Transfer Switch
4. Generator Connector Plug
5. Enclosed Circuit Breakers
6. Surge Protection Device (SPD)
7. Enclosure types
8. Alarm Beacon
9. Nameplates
10. Meter Socket

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance

### PART 2 –PRODUCTS

#### 2.1 ELECTRICAL ENCLOSURE CABINET

- A. Provide a free standing open bottom, heavy-duty stainless steel weather-tight and corrosion resistant custom fabricated electrical cabinet enclosure with sealed neoprene gasketing around all edges of the door. Cabinet enclosures shall be made of 14 gauge steel. The enclosure shall have the minimum dimensions as shown on the drawings. Actual sizes of the enclosures and lengths of the enclosures may be larger to incorporate all of the required equipment. The Contractor is responsible to properly size the control cabinet required at no additional cost to the Owner. Submit cabinet layout drawing with all dimensions shown for all installed devices.
- B. Control Cabinet shall have a natural mill finish.
- C. Enclosures shall have a sidewall mounted exhaust fan and intake louvers on the opposite sidewall. Ventilation louvers shall be equipped with filters, fan shall be equipped with a thermostat. Doors shall have vault type operating handles with three point catch. Doors shall be fully gasketed with opening of sufficient size to permit ready removal of any of the equipment installed in the compartments. Doors shall have provisions for pad locking.
- D. Heavy duty padlock with six sets of keys for each lock shall be furnished. Padlocks shall have forged brass case with brass shackle. Shackle shall be  $\frac{5}{16}$  inch diameter with  $2\frac{1}{2}$  inch clearance. Locks shall be No. 3841 as manufactured by Yale, or equal by Corbin.
- E. Pedestal roof shall slant to the rear of the enclosure. Drip shield shall extend over door opening. All exposed hardware shall be Type 316 stainless steel.
- F. Cabinet enclosures shall be leveled and bolted to a concrete pad using Type 316 stainless steel hardware.
- G. In the cabinet enclosure provide a linear LED light with light switch, a dedicated 120V receptacle for owner provided heater, ground bus, a duplex 120 Volt weather-proof convenience outlet, and a low temperature switch.
- H. Conduits shall enter through the open bottom entry.

#### 2.2 AUTOMATIC TRANSFER SWITCH

- A. The automatic transfer switch shall be true 3-pole, solid neutral type, microprocessor based control designed for an emergency and normal source of 480 Volts, 3 Phase, 4 Wire, 60 Hertz. Current ratings shall be as indicated on the drawings.

- B. Each switch shall be mounted in a NEMA 12 enclosure
- C. The complete switch assembly including accessories shall be listed under UL-1008 for use on emergency systems.
- D. The complete transfer switch assembly shall be factory tested to ensure proper operation and compliance with the specification requirements. A copy of the factory test report shall be available upon request.
- E. System Operation
  - 1. When the voltage on any phase of the normal source drops below 80% or increases to 120%, or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-9999 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contacts shall close to start the generating plant.
  - 2. The transfer switch shall transfer to emergency when the emergency source has reached specified voltage and frequency on all phases.
  - 3. After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-9999 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall automatically return to the normal source.
  - 4. After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-9999 seconds, factory set at 300 seconds.
- F. Construction
  - 1. The transfer switch shall be double throw, actuated by two electric operators momentarily energized, and connected to the transfer mechanism by a simple over center type linkage. Minimum transfer time shall be 400 milliseconds.
  - 2. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver-tungsten alloy. Separate arcing contacts with magnetic blowouts shall be provided on all transfer switches. Interlocked, molded case circuit breakers or contactors are not acceptable.
  - 3. The transfer switch shall be equipped with a safe manual operator, designed to prevent injury to operating personnel. The manual operator shall provide the same contact to contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly.

4. Transfer switch shall be adequately constructed to carry its full rated current on a continuous 24 hour basis in all approved enclosures and shall not show excessive heating or be subject to de-rating.
5. The minimum withstand and close-in current rating in symmetrical amperes shall be equal to or greater than the interrupting rating of the normal power source circuit breaker. In no case shall this rating be less than 20 times the transfer switch full load current rating. The switch contacts shall not weld or be damaged in any way as a result of a fault of up to the withstand and close-in rating.
6. The main contacts shall be visible for inspection without any major disassembly of the transfer switch.
7. A fully rated solid neutral bus bar with required AL-CU neutral lugs shall be provided.
8. Control components and wiring shall be front accessible. All control wires shall be multiconductor 18 gauge 600-volt SIS switchboard type point to point harness. All control wire terminations shall be identified with tubular sleeve-type markers.
9. The switch shall be equipped with 90 degrees C rated copper/aluminum solderless mechanical type lugs.

#### G. Controls

1. The transfer switch shall be equipped with a microprocessor based control system, to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with NiCad battery back up.
2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory I/O and communication circuits, with a watchdog/power fail circuit
3. A door mounted controller with a 20 character, LCD display, with a keypad, which allows access to the system shall be provided. The controller shall have password protection required to limit access to qualified and authorized personnel.
4. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.
5. The controller shall be capable of storing the following records in memory for access either locally or remotely:
  - i. Number of hours transfer switch is in the emergency position (total since record reset).
  - ii. Number of hours emergency power is available (total since record reset).
  - iii. Total transfer in either direction (total since record reset).
  - iv. Date, time, and description of the last four source failures.

- v. Date of the last exercise period.
  - vi. Date of record reset.
6. Reference the I-Drawings for additional requirements.

#### H. Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.
2. Programmable three phase sensing of the emergency source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases set at 20%, and phase sequence monitoring.
3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds, if not otherwise specified.
4. Time delay to control contact transition time on transfer to either source. Programmable 0-9999 seconds, factory set at 3 seconds.
5. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds if not otherwise specified, with overrun to provide programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.
6. Time delay on transfer to emergency, programmable 0-9999 seconds, factory set at 3 seconds.
7. A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.
8. A remote type load test switch shall be included to simulate a normal power failure, remote switch initiated.
9. A time delay bypass on retransfer to normal shall be included. Keypad initiated.
10. Dry contact, rated 10 Amps 120 volts AC, to close on failure of normal source to initiate engine starting.
11. Dry contact, rated 10 Amps 120 volts AC, to open on failure of normal source for customer functions.

12. Light emitting diodes shall be mounted on the microprocessor panel to indicate: switch is in normal position, switch is in emergency position and controller is running.
13. An exerciser shall be provided with (10) 7-day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise generating plant programmable in one-minute increments. Also include selection of either "no load" (switch will not transfer) or "load" (switch will transfer) exercise period. Keypad initiated.
14. Provision to select either "no commit" or "commit" to transfer operation in the event of a normal power failure shall be included. In the "no commit position," the load will transfer to the emergency position unless normal power returns before the emergency source has reached 90% of its rated values (switch will remain in normal). In the "commit position" the load will transfer to the emergency position after any normal power failure. Keypad initiated.
15. Two auxiliary contacts rated 10 Amp, 120 volts AC, shall be mounted on the main shaft, one closed on normal, the other closed on emergency. Both contacts will be wired to a terminal strip.
16. A three phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase to phase voltages simultaneously, for both the normal and emergency source.
17. A digital LCD frequency readout with 1% accuracy shall display frequency for both normal and emergency source.
18. An LCD readout shall display normal source and emergency source availability.
19. Include (2) time delay contacts that open simultaneously just (milliseconds) prior to transfer in either direction. These contacts close after a time delay upon transfer. Programmable 0-9999 seconds after transfer.

### 2.3 MANUAL TRANSFER SWITCHES

- A. The manual transfer switch shall be UL listed, designed for transfer between normal source and alternate source of 120/208 Volts, 3 Phase, 4 Wire, 60 Hertz. Current ratings shall be as indicated on the drawings
- B. Each switch shall be mounted in a NEMA 12 wall mounted enclosure.
- C. The transfer switch shall be service entrance rated of double throw contact construction with a 3-position emergency-off-normal external handle.
- D. NEMA Type 12 enclosures shall be as specified herein.

2.4 GENERATOR CONNECTOR PLUG

- A. UL 1682 Listed wall mounted 208VAC, 3-phase, 4-wire plus ground wall mounted male inlet plug. Current ratings shall be as indicated on the drawings.
- B. Housing shall be NEMA 4X with 30 degree mounting angle.
- C. Generator Plug shall be XXXXX Part #XXXXXX to match owner's existing generator cord configuration.

2.5 ENCLOSED CIRCUIT BREAKERS

- A. Circuit breakers shall be molded case, 3 pole unless otherwise noted, with voltage rating as required. Ampere rating shall be as shown on the Contract Drawings. Provide with service entrance rating where required.
- B. Main breaker shall be solid state with digital trip and adjustable trip setting with LED on face of breaker providing amps per phase. Provide auxiliary contacts for trip status to remote alarm.
- C. The interrupting capacity shall be not less than 25,000 Amperes, RMS symmetrical.
- D. All circuit breakers with 225 Ampere frames and larger shall have interchangeable trips.
- E. Enclosures shall meet the area NEMA designation for which they are located.
- F. NEMA Type 12 and 4X enclosures shall be as specified herein.

2.6 SURGE PROTECTION DEVICE (SPD)

- A. Electrical Service SPD
  - 1. Certify unit listed to UL 1449, 3rd Edition..
  - 2. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent devices. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal over-temperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
  - 3. SPD to be totally enclosed in a plastic NEMA 4X surface mounted enclosure and phase phase/line LEDs.
  - 4. Minimum surge current capability (single pulse rated) per phase shall be 50kA
  - 5. Voltage Protection Ratings (VPRs) shall not exceed the following:

| System Voltage | L-N  | L-G   | L-L   | N-G  |
|----------------|------|-------|-------|------|
| 120/240        | 700V | 1200V | 1200V | 800V |



6. Maximum Continuous Operating Voltage (MCOV):

|                |      |
|----------------|------|
| System Voltage | MCOV |
| 120/240        | 150V |

7. SPD shall be installed per manufacturer's installation instructions with lead lengths as short (less than 24") and straight as possible. Gently twist conductors together.

2.7 ENCLOSURES TYPES

- A. NEMA Type 12 enclosure shall be general purpose sheet steel.
- B. NEMA Type 4X enclosures shall be stainless steel.
- C. NEMA Type 8 shall be cast iron.
- D. All metal enclosures shall be finish painted over a rust inhibiting primer.

2.8 EXTERNAL ALARM BEACON

- A. Provide a 120-volt AC alarm beacon/siren in a weather proof, vapor-tight fixture with red thermoplastic vandal resistant lens, conduit box, and mounting accessories. Alarm beacon/siren and mounting accessories shall be designed to permit mounting in such a manner that rain water cannot stand or collect in the gasketed area of the fixture, between the base and globe. Alarm beacon/siren shall be installed on the exterior of electrical enclosure and shall be controlled and powered by the pump control panel.

2.9 NAMEPLATES

- A. Nameplates shall be provided for all special purpose tumbler switches, disconnect switches, remote control stations, motor starters, time clocks, panelboards, terminal cabinet, etc. to designate the equipment controlled and function.
- B. Nameplates shall be black and white laminated, phenolic material having engraved letters approximately 1/4 inch high, extending through the black face into the white layer.
- C. Nameplates shall be attached to the panel by self-tapping stainless steel screws or rivets.

2.10 METER SOCKET

- A. Provide a utility meter socket in a NEMA 3R enclosure with HASP cover provision of the type approved by the utility company.
- B. Meter Socket shall be 5 terminal, 200 Amp continuous rated, self-contained ringless type meter socket with a manual single handled bypass with locking jaw and safety arc shield.

## PART 3 – EXECUTION

### 3.1 INSTALLATION

- A. All field mounted devices shall be mounted four feet-six inches above the finished floor or grade. Devices shall be adequately supported on walls, columns or other supports. Furnish and install channel iron imbedded in the ground or floor to support devices where necessary.
- B. Devices installed in areas with hung ceilings, in toilet and administrative areas, and in similar areas, shall be installed flush with finished surfaces.
- C. All control equipment shall be identified as to the equipment it controls.

### 3.2 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700 – Contract Closeout

END OF SECTION 16085

SECTION 16120  
WIRE AND CABLES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY OF WORK

- A. The work of this section includes the furnishing, installing and testing of all wire, cable and appurtenances as specified herein and as shown on the drawings. All wiring of a given type shall be the product of one manufacturer.

1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300 – Submittals
- B. Submittals required under this section include, but are not limited to the following:
  - 1. Wire
  - 2. Cable
  - 3. Terminations
  - 4. Lugs
  - 5. Markers

1.4 QUALITY ASSURANCE

- A. Testing
  - 1. All 600 Volt wire insulation shall be tested with a megohm meter after installation. Tests shall be made at not less than 500 Volts. Submit a written test report of the results to the Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance

## 1.6 DESIGN CRITERIA

- A. Wire for branch circuits shall be Type XHHW or THWN-THHN.
- B. Wire for the service and pump feeders shall be Type XHHW.
- C. Single conductor wire for control, indication and metering shall be Type THWN/THHN No. 12 or 14 AWG, stranded.
- D. Wire for process instrumentation shall be twisted shielded pairs No. 16 AWG, stranded.
- E. Ground wires shall be Type THW, green. Bare ground wires shall be soft drawn copper, 98 percent conductivity.
- F. Except for control and signal leads, no wire smaller than number 12 AWG shall be used.

## PART 2 –PRODUCTS

### 2.1 MATERIALS

- A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.
- B. All conductors No. 12 AWG and larger sizes shall be stranded.

### 2.2 600 VOLT WIRE

- A. Type XHHW shall be cross-linked polyethylene, as manufactured by Pirelli Cable Corp., Collyer Insulated Wire Co., The Okonite Co. or equal.
- B. Type RHW shall be cross-linked polyethylene, as manufactured by Pirelli Cable Corp., Collyer Insulated Wire Co., The Okonite Co., or equal.
- C. Type THWN/THHN shall be as manufactured by Pirelli Cable Corp., Collyer Insulated Wire Co., The Okonite Co. or equal.
- D. Multi-conductor control cable shall be stranded, 600 Volt, cross-linked polyethylene insulated, neoprene jacketed, as manufactured by Rome Cable Corp., or equal.

### 2.3 INSTRUMENTATION CABLE

- A. Process instrumentation wire shall be twisted pair, 600 Volts, polyethylene insulated, aluminum tape, tinned copper braid shielded, polyvinyl chloride jacketed, as manufactured by Okonite Co., Belden Corp., or equal.

### 2.4 CONNECTORS AND TERMINAL LUGS

- A. Splices for No. 10 or No. 12 A.W.G. solid wires, such as for lighting branch circuits, shall be made with insulated wire connectors.

- B. Connectors and terminal lugs on wires No. 8 A.W.G. and larger shall be of the mechanical or clamp type.

## 2.5 WIRE AND CABLE MARKERS

- A. Wire and cable markers shall be “Omni-Grip” as manufactured by W.H. Brady Co., or equal.
- B. Wire and cables with diameters exceeding the capacity of the “Omni-Grip” shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by W.H. Brady Co., T&B Fasteners Inc., or equal.

## PART 3 – EXECUTION

### 3.1 INSTALLATION

- A. All conductors shall be carefully handled to avoid kinks or damage to insulation.
- B. All wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) shall be uniquely identified at each end with wire and cable markers.
  - 1. Where wiring originates from a motor control center or process control panel the wire identification number shall incorporate the terminal numbers used in the control center or panel and a number to identify the motor control center or panel.
  - 2. Wires shall be identified at both ends and at intermediate junction boxes, terminal cabinets, etc. Wire identification numbers shall be unique.
  - 3. A typed list of the numbers used at each motor control center and control cabinet shall be submitted with the as built drawings.
- C. Lubrications shall be used to facilitate wire pulling. Lubricants shall be U.L. approved for use with the insulation specified.
- D. Shielded instrumentation wire shall be installed from terminal to terminal with no splicing at any intermediate point.
- E. Shielded instrumentation wire shall be installed in termination and pull boxes that contain only shielded instrumentation wire.
- F. Shielding on instrumentation wire shall be grounded at the transmitter end only.
- G. No more than three lighting circuits, each from a different phase, shall be connected to a common neutral.

### 3.2 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700 – Contract Closeout

END OF SECTION 16120  
WIRES AND CABLES  
16120-3

## SECTION 16130

### RACEWAYS AND FITTINGS

#### PART 1 – GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

##### 1.2 SUMMARY OF WORK

- A. The work of this section includes the furnishing and installing of complete raceway systems as specified herein and as shown on the drawings.
- B. All raceway systems shall be complete with fittings, boxes or cabinets, and necessary connections to result in a complete system.

##### 1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300 – Submittals
- B. Submittals required under this section include, but are not limited to the following:
  - 1. Raceways.
  - 2. Boxes and Fittings.

##### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance

##### 1.5 DESIGN CRITERIA

- A. Except where otherwise shown on the drawings, or hereinafter specified, all raceways installed exposed shall be rigid heavy wall steel conduit.
- B. Except where otherwise shown on the drawings, or hereinafter specified, all raceways installed through the walls of and within the wet well shall be PVC coated rigid heavy wall steel conduit.
- C. Except where otherwise shown on the drawings and as specified herein all raceways installed underground shall be PVC Schedule 40.
- D. Rigid galvanized steel conduit sweeps shall be used where concealed conduits rise up through concrete slabs and exterior grade.

- E. All conduit of a given type shall be the product of one manufacturer.
- F. Unless otherwise hereinafter specified or shown on the drawings, all boxes shall be metal.
- G. Conduit wall penetration seals to be of the modular link type. Seals shall consist of a series of interlocking, molded synthetic rubber links, with heavy-duty plastic pressure plates, and corrosion resistant nuts and bolts. Seals to be designed to provide a hydrostatic seal between the conduit and wall penetration. Seals are to be Link Seal Modular Seals or equal.
- H. Seal and cap all empty conduits entrances into structures, seal shall be with a watertight silicone type sealant.

## PART 2 –PRODUCTS

### 2.1 RIGID CONDUIT

- A. Rigid heavy wall steel conduit shall be hot-dipped galvanized as manufactured by the Youngstown Sheet and Tube Co., Allied Tube and Conduit Corp., Wheeling-Pittsburgh Steel Corp., or equal.
- B. PVC coated rigid steel conduit shall have a 0.040 inch thick, polyvinyl chloride coating permanently bonded to hot-dipped galvanized steel conduit, as manufactured by Robroy Industries or equal.
- C. PVC conduit shall be rigid polyvinyl chloride Schedule 40 as manufactured by Carlon, Phillips Petroleum Co., Triangle Pipe & Tube Co., Inc., or equal

### 2.2 LIQUIDTIGHT, FLEXIBLE METAL CONDUIT, COUPLINGS AND FITTINGS

- A. Liquidtight, flexible metal conduit shall be Sealtite, Type UA, as manufactured by Anaconda American Brass Co., or equal by American Flexible Conduit Co., Inc., or equal.
- B. Fittings used with flexible conduit shall be of the screw-in type as manufactured by Thomas and Betts Co., Crouse-Hinds Co., O.Z. Manufacturing Co., or equal.

### 2.3 BOXES AND FITTINGS

- A. PVC fittings shall be as manufactured by Carlon, An Indian Head Co., O.Z. Manufacturing Co., or equal.
- B. Steel elbows and couplings shall be hot-dipped galvanized.
- C. Conduit hubs shall be as manufactured by Myers Electric Products, Inc., Raco Div., O.Z. Manufacturing Co., or equal.
- D. Conduit wall seals shall be Type WSK as manufactured by O.Z. Manufacturing, Co., or equal by Link Seal Co.

- E. Combination expansion-deflection fittings shall be Type XD as manufactured by Crouse-Hinds Co., or equal by Appleton Electric Co., O.Z. Manufacturing Co.
- F. Conduit seal bushings shall be Type CSB as manufactured by O.Z. Manufacturing Co., or equal by Crouse-Hinds Co.
- G. Explosion proof conduit seals shall be Type EYS as manufactured by O.Z. Manufacturing Co., or equal by Crouse-Hinds Co. and Appleton Electric Co.

## 2.4 CORROSION PROTECTION FOR GALVANIZED CONDUIT

- A. Corrosion protection for galvanized conduit shall be cold galvanized zinc based paint as manufactured by L.P.S. Co., Los Angeles, California, CRS Chemicals, Drecher, Pennsylvania, or equal.

## PART 3 – EXECUTION

### 3.1 INSTALLATION

- A. No conduit smaller than 3/4 inch electrical trade size shall be used, nor shall any have more than three 90 degree bends in any one run. Approved factory elbows shall be used when sharper bends are necessary. Pull boxes shall be provided as required or directed.
- B. No wire shall be pulled until the conduit system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the conduit system has been completed in every detail.
- C. The ends of all conduits shall be tightly plugged to exclude dust and moisture while the buildings are under construction.
- D. Conduit supports shall be spaced at intervals of eight feet or less, as required to obtain rigid construction.
- E. Conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface.
- F. All conduits shall be run at right angles to or parallel with surrounding wall and shall conform to the form of the ceiling. Diagonal runs will not be allowed. Bends in parallel conduit runs shall be concentric. All conduit shall be run perfectly straight and true.
- G. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.
- H. PVC conduits shall be installed using a fusing cement process. Conduits shall be water tight.
- I. Conduit terminating in gasketed enclosures shall be terminated with conduit hubs.



- J. Metallic heavy wall conduits shall be installed using threaded fittings. Threadless fittings may be used in isolated instances when approved by the Engineer.
- K. Liquidtight flexible metal conduit shall be used for all motor terminations and other equipment where vibration is present.
- L. When a conduit has to be cut in the field, it shall be cut square using a hand or power hacksaw cutter, or an approved pipe cutter using knives. The use of pipe cutter wheels will not be permitted. The cut ends of the field cut conduit shall be reamed to remove burrs and sharp edges. Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimensions and taper as specified for factory cut threads on conduits. Field cut threads shall be protected by a field applied cold galvanizing compound.
- M. Conduits entering structures below grade shall be furnished with a conduit seal bushing.
- N. Where ducts terminate at panelboards, terminal cabinets, etc. panel of sufficient width and depth shall be provided to maintain the 2 inch spacing between ducts or wireways shall be provided below panels, cabinets, etc.
- O. A ground wire shall be run in all runs of PVC conduit.
- P. All bends in PVC conduit shall be made using a hotbox and bending guide tool.
- Q. Conduits run underground below the highest known ground water level shall not enter buildings below this groundwater level without first being run through a drain manhole, handhole, or exterior pull box.

### 3.2 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700 – Contract Closeout

END OF SECTION 16130

## SECTION 16442

### PANELBOARDS

#### PART 1 – GENERAL

##### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

##### 1.2 SUMMARY OF WORK

- A. The work of this section includes the furnishing and installing of all panelboards as specified herein and as shown on the drawings. All panelboards shall be provided with the applicable NEMA enclosure in accordance with the Electrical Contract Drawings.

##### 1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300 – Submittals
- B. Submittals required under this section include, but are not limited to the following:
  - 1. Panelboards, including construction details and enclosures.
  - 2. Terminals and lugs
  - 3. Trim
  - 4. Buses
  - 5. Circuit Breakers
  - 6. Groundfault Circuit Interrupter

##### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance

##### 1.5 DESIGN CRITERIA

- A. Panelboard ratings shall be as shown on the drawings. All panelboards shall be rated for the intended voltage.
- B. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. “Standard for Panelboards” and “Standard for Cabinets and Boxes” and shall be so labeled where

procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

- C. Panelboards used for service entrance shall be Underwriter Laboratories labeled "Suitable for use as service equipment".

## PART 2 –PRODUCTS

### 2.1 PANELBOARD CONSTRUCTION

#### A. Interiors

1. All interiors shall be completely factory assembled with circuit breakers, wire connectors, and buses. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper wire of the sizes indicated.
2. Interiors shall be designed such that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be such that circuits may be changed without machining, drilling or tapping.
3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.
4. A factory provided label shall be provided listing panel type, number of circuit breakers and ratings.

#### B. Buses

1. Main bus shall be copper. Full size neutral bars shall be included. Phase bussing shall be full height without reduction. Cross connectors shall be copper. All buses shall be tinned.
2. Main bus shall be distribution phase sequence type configuration to allow installation of two or three pole circuit breakers at any location.
3. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
4. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.
5. Solderless main lugs or main circuit breakers shall be furnished as shown on the drawings.
6. Bus bracing to be at least equal to the interrupting rating of lowest rated circuit breaker installed in panel. Series rated breakers and panels shall not be acceptable.

### C. Boxes

1. Recessed boxes shall be made from galvanized code gauge steel having multiple knockouts unless otherwise noted. Surface mounted boxes shall be painted to match the trim. Boxes shall be of sufficient size to provide a minimum gutter space of four inches on all sides.
2. Surface mounted boxes shall have an internal and external finish as specified herein. Surface mounted boxes shall be field punched for conduit entrances.
3. At least four interior mounting studs shall be provided.

### D. Trim

1. Hinged door-indoor construction shall enclose all circuit breaker handles and shall be included in all panel trims.
2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48 inch in height shall have a vault handle and three point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Two keys shall be supplied for each lock. All locks shall be keyed alike. A directory frame and card having a transparent cover shall be furnished on each door.
3. Trims shall be fabricated from code gauge sheet steel.
4. Trims for flush panels shall overlap the box by at least 3/4 inch all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

### E. Manufacturer

1. 120/240 Volt, single phase, 3 wire, panelboards rated for 200 Amps and less shall be a load center type as manufactured by Eaton, Square D and General Electrical.

## 2.2 CIRCUIT BREAKERS

- A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the drawings. Circuit breaker mounting shall not exceed 78 inches above floor.
- B. Circuit breakers shall be molded case, bolt-in type.
- C. Circuit breakers installed in 120/240 Volt and 120/208 Volt panelboards shall have an interrupting capacity of not less than the RMS symmetrical panelboard rating as indicated on the drawings.
- D. Main circuit breaker shall be attached to the main vertical bus.

- E. Main breaker shall have solid state digital trip unit with adjustable long, short, and instantaneous trip settings.

### 2.3 GROUND FAULT CIRCUIT INTERRUPTER (GFCI)

- A. GFCI shall be provided for circuits where indicated on the drawings. GFCI units shall be molded case, bolt-on breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the breaker mechanism. The unit shall be U.L. listed Class A Group I device (30 milliamp sensitivity, 25 millisecond trip time), and an interrupting capacity matching the circuit breakers in the panelboards.

## PART 3 – EXECUTION

### 3.1 INSTALLATION

- A. Boxes for surface mounted panelboards shall be mounted so there is at least 1/2 inch air space between the box and the wall.
- B. Circuit directories shall be typed identifying location and nature of load served.
- C. Panelboards installed in areas with finished walls shall be installed recessed into the wall with the front of the panel flush with the finished wall

### 3.2 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700 – Contract Closeout

END OF SECTION 16442

SECTION 16500  
LIGHTING SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental Conditions, Division 0 and Division 1 Specification Sections, apply to this section.

1.2 SUMMARY OF WORK

- A. The work of this section includes the furnishing and installing of complete lighting systems including panelboards, transformers, lighting fixtures, receptacles, switches, contactors, clocks and all accessories and appurtenances required as specified herein and as shown on the drawings.

1.3 SUBMITTALS

- A. Manufacturer's literature and brochures shall be submitted for all items to be furnished in accordance with the provisions of Section 01300 – Submittals
- B. Submittals required under this section include, but are not limited to the following:
  - 1. Light Switches
  - 2. Receptacles
  - 3. Lighting Fixtures
  - 4. Device Plates

1.4 QUALITY ASSURANCE

- A. All lighting fixtures shall be in accordance with the National Electrical Code and shall be constructed in accordance with the Underwriters Laboratories “Standards for Safety, Electric Lighting Fixtures.” All lighting fixtures shall be Underwriters Laboratories labeled.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance

## PART 2 –PRODUCTS

### 2.1 LIGHT SWITCHES

- A. NEMA WD 1, UL 20, Heavy-Duty, AC only general-use toggle switch.
- B. Rated 20 Amperes, 120/277 Volts for inductive and resistive loads
- C. U.L. and CSA Listed.

### 2.2 RECEPTACLES

- A. NEMA WD 1, UL 498, Heavy-duty general use receptacle.
- B. NEMA WD 6, straight blade type for rated current and phases as indicated on drawings.

### 2.3 LED LIGHT FIXTURES

- A. The fixture shall be tested to IESNA LM-79-08 and LM-80 Testing Standards at 25° C ambient temperature
- B. The LED package shall be designed around the lumen maintenance of 87% at 60,000 hrs. and is to be expected to achieve L70 at 100,000 hrs.
- C. The Light Engine shall be a high efficacy LED light engine equipped with brand-name LEDs available in outputs of 100%, 85%, 70% and 55
- D. The LED Drivers shall be Electronic Class 2, high efficiency with the following power factor correction (PFC):
  - 1. Standard Non-Dimming Driver (PFC>0.95).
  - 2. Dimming Drivers (PFC>0.90).

### 2.4 DEVICE PLATES

- A. Plates shall be of the required number of gangs for the application involved and shall be Type 302 (18-8) high nickel stainless steel of the same manufacturer as the device.

## PART 3 – EXECUTION

### 3.1 INSTALLATION

- A. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for Connection to the branch circuit wires at the outlet. All pendant mounted fixtures shall be mounted plumb with floors and walls.

3.2 CONTRACT CLOSEOUT

A. Provide in accordance with Section 01700 – Contract Closeout

END OF SECTION 16500