

Section 16051

**ELECTRICAL CONSTRUCTION**

Part 1 GENERAL

1.01 SUMMARY

This Section includes provision of all materials, equipment, supplies, supervision, tools, labor, and all other appurtenances required to install, test, adjust, and place in operation the electrical system as shown on Plans and specified herein. Contractor to furnish all component pieces, wiring, piping, and accessories necessary for a complete and workable system placed in operation.

1.02 MEASUREMENT AND PAYMENT

No separate payment for work performed under this Section. Include cost of same in Contract price bid for work of which this is a component part.

1.03 REFERENCES

This specification references the following publications in their current editions. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

- A. ASTM B3: Standard Specification for Soft or Annealed Copper Wire
- B. ASTM B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. ASTM D2802: Standard Specification for Ozone-Resistant Ethylene-Alkene Polymer Insulation for Wire and Cable
- D. DLA A-A-55809B: Insulation Tape, Electrical, 600V, Polyvinyl Chloride, Pressure-Sensitive Adhesive
- E. DLA A-A-59213A: Splice Connectors
- F. DLA QPL-W-C-375-QPD: Circuit Breakers, Molded Case, Branch Circuit and Service
- G. DLA W-S-896G: Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification)
- H. ICEA S-95-658/NEMA WC 70: Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
- I. ICEA S-96-659/NEMA WC 71: Standard for Nonshielded Cables Rated 2001-5000 Volts for use in the Distribution of Electric Energy

- J. ICEA S-93-639/NEMA WC 74: 5-46KV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
- K. IEEE C62.2: Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems
- L. NFPA 70: National Electrical Code (NEC)
- M. NFPA 79: Electrical Standard for Industrial Machinery
- N. UL 44: Standard for Safety Thermoset-Insulated Wires and Cables
- O. UL 67: Standard for Safety Panelboards
- P. UL 83: Standard for Safety Thermoplastic-Insulated Wires and Cables
- Q. UL 94: Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
- R. UL 98: Standard for Safety Enclosed and Dead-Front Switches
- S. UL 489: UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
- T. UL 498: Standard for Safety Attachment Plugs and Receptacles
- U. UL 510: Standard for Safety Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape
- V. UL 514A: Standard for Safety Metallic Outlet Boxes
- W. UL 514B: Standard for Safety Conduit, Tubing, and Cable Fittings
- X. UL 514C: Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
- Y. UL 514D: Standard for Safety Cover Plates for Flush-Mounted Wiring Devices
- Z. UL 854: Standard for Safety Service-Entrance Cables
- AA. UL 870: Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings

1.04 SUBMITTALS

Submit the following in accordance with Sections 01330 - "Submittal Procedures" and 01782 – "Operation and Maintenance Data."

- A. Submitted literature to be marked in ink to show the paragraph in the Specification Sections for which the material applies. Submit data in 3-ring binders.

B. Summary Sheet:

List any and all deviations in dimensions, capacities, or ratings from the dimensions, capacities, or ratings as shown on Plans or in Specification Sections.

C. Tabulated Data:

Furnish tabulated data for all required products that are described in PART 2 of this Section.

D. Catalog Data:

Furnish catalog data cut sheets for all required products that are described in PART 2 of this Section, including highlighted indication of the following information when applicable for each submitted product.

1. Manufacturer's product name and model number
2. Tag number identical to the one designated on Plans
3. Functional name
4. Features
5. Options
6. Dimensions
7. Description of construction, including enclosure rating
8. Service requirements (e.g., power, water, etc.)
9. Short-circuit current rating

E. Control Schematics and Instrumentation Diagrams:

Furnish control schematics and instrumentation diagrams, when required, made from reproductions of the control schematics shown on Plans with modifications as required but not redrawn in another format.

F. Submit shop drawings delineated by specification number with all information for one piece of equipment provided as one package.

G. Operation and Maintenance Manuals:

Furnish operation and maintenance manuals in accordance with Contract Documents and including the following.

1. Latest approved sets of shop drawings

2. Wiring diagrams, including wiring sizes and types, designation and routing of conduits, and location, functional name, and manufacturer's designation of items to which wiring is connected.
  3. Dimensional prints
  4. Bills of material
  5. Shut-down procedures
  6. Safety instructions
- H. Follow the related requirements listed in Item 1.05.O where applicable.

#### 1.05 RELATED REQUIREMENTS

- A. Provide complete and operational systems for both normal and standby electric power systems, normal and emergency lighting systems, grounding systems and other specified systems, including the installation and wiring of miscellaneous equipment and devices. Perform all work and testing as indicated and specified.
1. Provide conduit, wiring and connections for power, control, lighting, instrumentation and alarms for equipment furnished by others unless otherwise specified and indicated.
  2. Provide temporary circuits, over current devices, conduit and wiring, and other equipment required during construction and change-over from existing to proposed electric system.
  3. Provide electrical system studies including a short circuit and protective device coordination study and an arc-flash study for the electrical distribution system constructed under this contract.
  4. Install all raceways and equipment to meet the seismic design criteria of the project location. Raceways supports and equipment anchoring shall be provided as specified in the Division 16 sections which form a part of the Contract Documents.
  5. Disconnecting, removing, and relocating existing electrical equipment is a part of this Contract and is specified under Technical Specification Section 16060 - "Electrical Demolition" and this Section. Make equipment scheduled for removal free of shock hazard.
  6. Provide electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment. Make equipment scheduled for relocation free of electrical shock hazard.

7. The equipment enclosure classification of the plant areas are indicated on the Plans. Provide all equipment, devices and material meeting the requirements for these area classifications unless otherwise noted or specified.
  8. Review the electrical underground system and the civil yard piping. Install the electrical underground system in a manner that avoids conflicts with manholes, catch basins, etc. provided under other Divisions of the specifications.
- B. The Plans and other Specification Sections show and/or specify those features required to describe and illustrate functional requirements of the electrical system.
- C. Work Shown on Plans:
1. The locations of outlets shown on the Plans are approximate only and are to be located exactly as necessary to fit the location of the equipment and not conflict with the installation of construction of the other trades.
  2. Wire sizes are based on the loads indicated on the One-Line Diagrams and panel schedules as reflected by relevant items of the Specification Sections. Final wire sizes to be in accordance with the NEC, based on the requirements of the equipment actually furnished.
  3. All relocation of outlets and changes in wire and conduit sizes to be at no additional cost to the Owner.
  4. Review the electrical underground system and the civil yard piping. Install the electrical underground system in a manner that avoids conflicts with manholes, catch basins, etc. provided under other Divisions of the specifications.
- D. Section 01110 - "Summary of Work"
- E. Section 01330 – "Submittal Procedures"
- F. Section 01782 – "Operation and Maintenance Data"
- G. Section 16060 - "Electrical Demolition"
- H. Section 16111 - "Conduit, Fittings, and Bodies"
- I. Section 16195 - "Electrical Identification"
- J. Section 16402 - "Underground Duct Banks"
- K. Conform to the construction schedule and progress of the other trades
- L. Set all electrical apparatus in place whether supplied herein or under other Specification Sections. Connect, test, service, and place equipment in operation.

M. Interference and Erroneous Locations

1. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.
2. Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.
3. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

N. Seismic Design Requirements

1. Conform to the requirements indicated on the structural Plans and as specified in Technical Specification Section 01110 - "Summary of Work" and all Sections in Division 16.
2. All raceways and equipment installed under Division 16 Sections shall use earthquake resistant supporting systems as specifically required in each applicable section.

O. Approval and Marking Equipment

1. Insure that devices and materials are listed and/or labeled by UL, wherever standards have been established by that organization. Where a UL listing is not available for equipment, submit certified test reports of a Nationally Recognized Testing Laboratory (NRTL), approved by the local inspecting authority, indicating that equipment is in conformance with local code requirements or any other applicable requirements. Tests and inspections for approval of equipment shall be performed at no additional cost to Owner.
2. Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

1.06 QUALITY ASSURANCE

A. Manufacturers

1. Furnish products of manufacturers specified in PART 2 of this Section. All products to be approved in writing prior to installation.
2. The products as described herein are applicable when required by Plans and/or other Specification Sections and are included to complement the electrical characteristics, ratings, and/or modifications as shown on Plans.
3. All products of a given type to be furnished by a single manufacturer.

4. All products as described in the following to provide satisfactory operation and to require minimal maintenance under the following environmental conditions.
  - a. Nonweatherproof Products/Controlled Environment:
    - (1) Indoors protected from corrosive atmosphere and elements of the weather.
    - (2) Temperature: 60° to 100°F
    - (3) Relative Humidity: 95 percent
  - b. Weatherproof Products/Noncontrolled Environment:
    - (1) Outdoors and indoors subjected to corrosive atmosphere or elements of the weather.
    - (2) Temperature: 10°F to 120°F
    - (3) Relative Humidity: 100 percent
5. Minimum interrupting ratings of the products to be at least equal to the available RMS symmetrical short-circuit current at the line terminals of the product, when applicable.

**B. Construction**

Comply with all National Electrical Code (NEC) requirements, local ordinances, and all other pertinent codes and standards

**C. Qualifications of Electrical Subcontractor**

1. The Electrical Subcontractor shall have been engaged in work of a similar nature to this contract for the past 5 years.
2. The Electrical Subcontractor shall have a minimum of five projects of equal or greater size with the type of equipment specified under this project.

**1.07 SYSTEM DESCRIPTION (NOT USED)**

**1.08 DELIVERY, STORAGE, AND HANDLING**

- A. Maintain materials and equipment in like-new condition, including the use of heat lamps and suitable coverings to prevent accumulation of excess condensation and construction dirt.
- B. Protect materials and equipment from corrosive liquids, gases, dust, and other agents that could cause damage.

- C. Store equipment in compliance with manufacturer's recommendations and as specified herein.
  - D. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction.
  - E. Do not store equipment outdoors
  - F. Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.
- 1.09 PROJECT SITE CONDITIONS (NOT USED)
- 1.10 DEFINITIONS (NOT USED)
- 1.11 SEQUENCING
- A. Coordinate electrical equipment installation with other components.
  - B. Arrange for chases, slots and openings in the building structures during the progress of construction to allow for the electrical installation.
  - C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
  - D. Sequence, coordinate and integrate the installation of electrical materials and equipment for efficient flow of the work.
  - E. Coordinate the installation of large equipment prior to closing in the building.
  - F. Sequencing and scheduling work at existing facilities:
    - 1. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant shall function properly with no disruption of power.
    - 2. Continuous service is required on all circuits and outlets affected by the work detailed in the contract, except where the Project Manager will permit an outage for a specific time.
    - 3. Obtain the Project Manager's consent before removing any circuit from continuous service.
    - 4. Coordinate electrical power outages to the electrical systems and equipment with the Project Manager.



5. Where duration of proposed outage cannot be allowed, phase the work to allow the system or equipment to be re-connected to the electrical power system within the time frame allowed by the Owner or provide temporary power connections as required to maintain service to the systems or equipment.
  6. The temporary power can be from a generator or another part of the facility not affected by the outage provided there is sufficient spare capacity.
- G. Set all electrical apparatus in place whether supplied herein or under other Specification Sections. Connect, test, service, and place equipment in operation.

#### 1.12 SCHEDULING

- A. The Contractor shall contact, arrange for, and schedule initial service from the utility companies, as required. Any and all charges required by these utility companies for permanent service shall be paid by the Contractor.

B. Telephone Service:

Provide all conduit and wire to service pole, extend conduit up pole as required by telephone company. Connections at pole shall be made by the telephone company. Perform work at service pole in accordance with telephone company's requirements.

C. Electrical Service:

Where the project requires a new or modified electrical service provide the following:

1. Contact CenterPoint Energy for coordinating the utility power requirements for the project.
2. CenterPoint Energy will furnish and install per Plans and Contract Documents:
  - a. Pad-mounted transformer with primary cable, connection of all primary and secondary cables and metering equipment
  - b. Pole and pole-mounted transformer with connection of all secondary cables and metering equipment
3. Contractor shall provide the following in accordance with the Plans and Contract Documents:
  - a. Concrete pad for transformer
  - b. Primary and secondary duct lines
  - c. Secondary cables of sufficient length for termination at the transformer
  - d. Grounding at pad and service pole
  - e. Conduit at service pole

- f. Metering equipment
  - g. As required, provide all conduit and wire to service pole, extend conduit up pole for distance of 10 feet, and leave sufficient length of conductors to reach the electrical distribution system overhead conductors.
- 4. Connections at pole shall be made by the power company.
  - 5. Perform work at service pole in accordance with the power company's requirements.
- D. The final, complete installation of all utilities shall comply with all state and local statutory requirements having jurisdiction. The 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.

Part 2 PRODUCTS

2.01 MANUFACTURER(S)

A. Conduit and Appurtenances

Conduit, fittings, and bodies shall be purchased per Section 16111 - "Conduit, Fittings, and Bodies."

B. Conductor, Cable, and Appurtenances

- 1. Power and Control Cable:
  - a. Cablec (Anaconda)
  - b. Cerro Wire and Cable
  - c. Okonite
  - d. Southwire Cable Company
  - e. Triangle
  - f. Or Approved Equal
- 2. Shielded Instrumentation Cable:
  - a. Belden #8760 or #8770
  - b. Eaton-Dekoron #1852 or #1862

- c. Or Approved Equal
- 3. Wire Connector:
  - a. 3M Company Type Scotchlock
  - b. Ideal Industrial Inc. Type Wire-Nut
  - c. Or Approved Equal
- 4. All-Purpose Electrical Tape:
  - a. 3M Company Type Scotch #33+
  - b. Plymouth Rubber Company Inc. Type Premium Black #4453
  - c. Or Approved Equal
- 5. Fire and Electric Arc-Proofing Tape:
  - a. 3M Company Type Scotch #77
  - b. Plymouth Rubber Company Inc. Type Slipknot #30
  - c. Or Approved Equal
- C. Control Devices
  - 1. Push-Button Switch and Selector Switch:
    - a. Square D Class 9001
    - b. General Electric Type CR2940
    - c. Or Approved Equal
  - 2. Pilot Light:
    - a. Square D Class 9001
    - b. General Electric Type R2940
    - c. Or Approved Equal
    - d. Manufacturer and catalog number of lamp to be:
      - (1) General Electric #755
      - (2) Sylvania #755
      - (3) Or Approved Equal

3. General Purpose Relay:
    - a. Square D Type K
    - b. General Electric Type CR120H
    - c. Or Approved Equal
  4. Industrial Relay:
    - a. Square D Type X
    - b. General Electric Type CR120B
    - c. Or Approved Equal
  5. Time-Delay Relay:
    - a. Square D Type JCK
    - b. General Electric Type CR122BT
    - c. Or Approved Equal
- D. Light Switch, Lockout Switch, and Appurtenances
1. Light Switch and Lockout Switch
    - a. Single pole type:
      - (1) Bryant #4901-I
      - (2) Pass & Seymour #20AC1-I
      - (3) Or Approved Equal
    - b. Double pole type:
      - (1) Bryant #4902-I
      - (2) Pass & Seymour #20AC2-I
      - (3) Or Approved Equal
    - c. Three-way type:
      - (1) Bryant #4903-I
      - (2) Pass & Seymour #20AC3-I
      - (3) Or Approved Equal

- d. Four-way type:
  - (1) Bryant #4904-I
  - (2) Pass & Seymour #20AC4-I
  - (3) Or Approved Equal
- 2. Light Switch Cover Plate
  - a. Nonweatherproof ivory thermoplastic type to be manufactured by switch manufacturer with compatible catalog number as required.
  - b. Nonweatherproof steel type:
    - (1) Hinds #DS32
    - (2) Appleton #FSK-1TS
    - (3) Or Approved Equal
  - c. Nonmetallic weatherproof type:
    - (1) Raco #5087
    - (2) Taymac
    - (3) Or Approved Equal
- 3. Cast Device Box:
  - a. Crouse-Hinds Type FS
  - b. Appleton Type FS
  - c. Or Approved Equal
- E. Receptacle and Appurtenances
  - 1. Receptacle:
    - a. Bryant #5262-I
    - b. Pass & Seymour #5262-I
    - c. Or Approved Equal

2. Cover Plate:

Type, manufacturer, and catalog number to be as follows.

- a. Nonweatherproof ivory thermoplastic type to be manufactured by receptacle manufacturer with compatible catalog number as required.
- b. Nonweatherproof steel type:
  - (1) Crouse-Hinds #DS23
  - (2) Appleton #FSK-1DR
  - (3) Or Approved Equal
- c. Nonmetallic weatherproof type:
  - (1) Raco #5060-0 (horizontal duplex), #5051-0 (vertical duplex), #5061-0 (horizontal GFCI), #5052-0 (vertical GFCI)
  - (2) Taymac
  - (3) Or Approved Equal

F. Lighting Panel

- 1. 240 volts AC:
  - a. Square D Type NQO
  - b. General Electric
  - c. Cutler-Hammer
  - d. Siemens
  - e. Or Approved Equal
- 2. 480/277 volts AC:
  - a. Square D Type NEHB
  - b. General Electric
  - c. Cutler-Hammer
  - d. Siemens
  - e. Or Approved Equal

- G. Power Panel:
  - 1. Square D Type I-Line
  - 2. General Electric Type CCB
  - 3. Cutler-Hammer Type CDP
  - 4. Siemens
  - 5. Or Approved Equal
  
- H. Wireway:
  - 1. Hoffman Engineering Company
  - 2. Wiegmann & Co. Inc.
  - 3. Or Approved Equal
  
- I. Lighting Transformer:
  - 1. General Electric Type QB, QMS, or QL as required per size
  - 2. Cutler-Hammer Type EP or DS-3 as required per size
  - 3. Or Approved Equal
  
- J. Safety Switch:
  - 1. Cutler-Hammer Type H-600
  - 2. General Electric Type TH
  - 3. Or Approved Equal
  
- K. Molded Case Circuit Breaker:
  - 1. Square D
  - 2. General Electric
  - 3. Cutler-Hammer
  - 4. Siemens
  - 5. Or Approved Equal

L. Overvoltage Surge Protection

1. Lightning Arrester:

- a. General Electric Tranquell Series HE
- b. Cutler-Hammer Square D
- c. Or Approved Equal

2. Surge Capacitor:

- a. General Electric Dielektrol (used in combination with G.E. Tranquell arrester)
- b. Cutler-Hammer
- c. Square D
- d. Or Approved Equal

M. Three-Phase Power Monitor:

- 1. Diversified Electronics SLM-440-ASA
- 2. Square D
- 3. Or Approved Equal

N. Power Factor Correction Capacitor:

- 1. ASEA Type CLMD
- 2. Or Approved Equal

2.02 MATERIALS AND/OR EQUIPMENT

A. Conduit and Appurtenances

Conduit, fittings, and bodies shall be installed per Section 16111 - "Conduit, Fittings, and Bodies."

B. Conductor, Cable, and Appurtenances

- 1. Conductor to be soft annealed bare copper per ASTM B3, Class B strand per ASTM B8. Size 12 AWG and 10 AWG for power circuits to be solid above ground; all other wire including all control wire to be stranded.



2. Power and Control Cable

a. Above Ground:

UL-listed Type THW or Type THWN rated for 600 volts AC and 75°C minimum. UL-listed Type THWN-2 rated 600 volts AC and 90°C minimum. Insulation to be PVC. Conductors and insulation to be in accordance with the latest edition of UL 83. Type THWN to have abrasion-resistant nylon jacket over insulation. Use THWN-2 for sizes No. 2 and larger.

b. Below Ground:

UL-listed Type XHHW-1 rated for 600 volts AC and 90°C dry and 75°C wet. Insulation to be cross-linked thermosetting polyethylene. Conductors and insulation to be in accordance with UL 44, ICEA S-95-658/NEMA WC 70, ICEA S-96-659/NEMA WC 71, and ICEA S-93-639/NEMA WC 74.

c. Below Ground:

When indicated on Plans, UL-listed Type RHH, RHW, USE, VW-1 rated for 600 volts AC and 75°C. Insulation to be either ethylene propylene with chlorosulfonated polyethylene outer jacket or flame-retardant ethylene propylene. Conductors, insulation, Chlorosulfonated polyethylene, and Ethylene propylene to be in compliance with the latest editions of ICEA S-95-658/NEMA WC 70, ICEA S-96-659/NEMA WC 71, and ICEA S-93-639/NEMA WC 74, ASTM D2802, UL 44, and UL 854.

3. Shielded Instrumentation Cable

UL-listed Type VW-1 rated for 300 volts DC and 60°C minimum. Insulation to be polyethylene with aluminum polyester, 100 percent shield coverage, and chrome PVC jacket. Conductors to be twisted, stranded, tinned copper with stranded tinned copper drain wire.

4. Wire Connector

UL-listed with fire-resistant, flame-retardant, thermoplastic shell in accordance with latest edition of DLA A-A-59213A.

5. All-Purpose Electrical Tape

UL-listed, flame-retardant, weather-resistant vinyl plastic construction in accordance with latest editions of UL 510 and DLA A-A-55809B.

6. Fire and Electric Arc-Proofing Tape

Flexible, conformable, unsupported intumescent elastomer with self-extinguishing characteristics in accordance with UL 94.

C. Control Devices

1. Push-Button Switch and Selector Switch

Heavy-duty, oil-tight construction rated for 600 volts AC, 10 amps continuous.

2. Pilot Light

a. Push-to-test transformer type with construction and rating as specified in paragraph 2.02 C.1.

b. Light to include a miniature bayonet base lamp designed for 6.3 volts AC with a minimum life of 20,000 hours.

3. General Purpose Relay

Plug-in type rated 240 volts AC, 10 amps continuous.

4. Industrial Relay

Heavy-duty type with plug-in contact cartridges rated 600 volts AC, 10 amps continuous.

5. Time-Delay Relay

Solid state, plug-in type rated 600 volts AC, 10 amps continuous.

D. Light Switch, Lockout Switch, and Appurtenances

1. Light Switch and Lockout Switch

UL-listed with ivory toggle rated 120-277 volts AC, 20 amps continuous in accordance with the latest edition of DLA W-S-896G.

2. Cast Device Box

Copper-free aluminum in accordance with the latest editions of UL 498, UL 514A – UL 514D, and DLA A-A-50563A.

E. Receptacle and Appurtenances

UL-listed, duplex grounding type with ivory face rated 125 volts AC, 15 amps continuous.

F. Lighting Panel

1. UL- latest edition, Type 1, Class 1. Panel to include a UL service entrance label when required.
2. System voltage rating to be 240 volts AC or 480/277 volts AC as shown on Plans. Minimum integrated rating of 240 volts AC rated panel to be 10,000 RMS symmetrical amps, and minimum integrated rating of 480/277 volts AC rated panel to be 14,000 RMS symmetrical amps unless shown otherwise on Plans.
3. Buses to be silver plated copper. Minimum size of buses and breaker frames to be 100 amps unless shown otherwise on Plans.
4. Transformer-fed panels to have main breaker to match system. Breakers to be plug-in type in accordance with the latest edition of DLA QPL-W-C-375-QPD.
5. Enclosure to be NEMA 1 for controlled environment and NEMA 3R for noncontrolled environment unless shown otherwise on Plans.

G. Power Panel

1. UL-latest edition, Type 1, Class 1. Panel to include a UL service entrance label when required.
2. System voltage rating to be 600 volts AC. Minimum integrated rating to be 22,000 RMS symmetrical amps unless shown otherwise on Plans.
3. Buses to be silver plated copper. Minimum size of buses and breaker frames to be 100 amps unless shown otherwise on Plans.
4. Breakers to be plug-in type in accordance with the latest edition of DLA QPL-W-C-375-QPD.
5. Nonweatherproof enclosure to be NEMA 1 construction, and weatherproof enclosure to be NEMA 3R construction unless shown otherwise on Plans.

H. Wire Enclosure

1. UL-listed, nonweatherproof, lay-in, hinged type with fasteners and NEMA 1 construction in accordance with the latest edition of UL 870.
2. UL-listed, weatherproof, flanged, hinged type with screw clamps and NEMA 4X stainless steel construction in accordance with the latest editions of UL 870, and NFPA 79.

I. Lighting Transformer

1. UL-listed dry type in accordance with the latest editions of applicable NEMA,

ANSI, UL, ASA, and IEEE standards.

2. Single-phase voltage rating to be 480 or 240 x 480 volts primary and 120/240 volts secondary unless shown otherwise on Plans.
3. Sizes below 1 kVA not required to have taps. Sizes 1 kVA to 15 kVA to have two 5 percent taps below rated primary volts minimum. Sizes above 15 kVA to have two 2½ percent taps above rated primary volts and four 2½ percent taps below primary volts minimum.
4. Temperature rise rating to be 115°C
5. All openings to be covered with 3/16" x 3/16" wire mesh attached securely from the inside.

J. Safety Switch:

1. UL-listed, heavy-duty type with visible blades and indicator handle in accordance with latest edition of UL 98.
2. Nonweatherproof enclosure to be NEMA 1 construction, and weatherproof enclosure to be NEMA 4 stainless steel construction, unless shown otherwise on the Plans.

K. Molded Case Circuit Breaker

1. UL-listed, thermal magnetic type in accordance with latest editions of UL 489 and DLA QPL-W-C-375-QPD.
2. Breaker to include the following features:
  - a. Toggle type handle with quick-make, quick-break, over-center switching mechanism.
  - b. Handle position trip indication.
  - c. Inverse time delay and instantaneous circuit protection to be provided by each pole.
  - d. Common trip for two-pole and three-pole types.
  - e. 100 amp frame size minimum.
  - f. Single adjustment variable magnetic trip elements for frame sizes greater than 100 amps.
  - g. Enclosures, when required, to be as specified in paragraph 2.02 J.2.

L. Lighting Fixtures

1. General:

Provide lighting fixtures, of the size, type, and rating indicated on Plans, complete with, but not necessarily limited to, lamps, lamp holders, reflectors, ballasts, support hardware, and wiring.

2. Ballasts - Fluorescent:

Provide ballasts with high-power factor, rapid start, class "P," low noise with "A" sound rating, thermally protected, encased and potted. Ballasts to have 0°F temperature rating.

3. Ballasts – High-Intensity Discharge (HID):

Provide HID ballasts with high-power factor, "B" sound rating. Ballasts to have 0°F temperature rating.

M. Overvoltage Surge Protection

1. Lightning Arrester:

a. 650 volt minimum rated unit in accordance with the latest edition of IEEE C62.2.

b. Weatherproof enclosure with corrosion resistant mounting bracket and hardware required for installation as shown on Plans.

2. Surge Capacitor:

a. 650 volt minimum rated unit sized at 1 microfarad minimum per pole.

b. Enclosure and mounting hardware to be in compliance with paragraph 2.02 M.1.b.

N. Three-Phase Power Monitor

1. Unit to detect phase failure, phase voltage unbalance, phase reversal, and undervoltage.

2. Monitor to include the following features:

a. Voltage adjustment

b. Automatic reset

c. 5A, 125V AC minimum rated contacts

d. Response delay of 3 seconds minimum

- e. UL component recognized
- O. Power Factor Correction Capacitor
  - 1. Dry metallized-film construction that eliminates free liquids.
  - 2. Polypropylene dielectric to be utilized that result in less than 0.5 watts per KVAR losses, inclusive of discharge resistor losses.
  - 3. All elements to be internally protected
  - 4. Discharge resistors to reduce the residual voltage to 50 volts or less within one minute after the capacitor has been disconnected from the motor circuit.
  - 5. Enclosure to be rated NEMA 1 minimum for indoor installation. Provisions to be made for enclosure to be rated NEMA 4X for outdoor installation.
  - 6. Largest size allowed by motor manufacturer to be provided so that power factor does not exceed unity at no-load conditions preventing a leading power factor from occurring under all conditions.

2.03-2.04 (NOT USED)

Part 3 EXECUTION

3.01 GENERAL

- A. Install all equipment and materials in accordance with the recommendations of each equipment manufacturer.
- B. Use only persons skilled in type of work required by Plans and Specification Sections
- C. Earth and rock excavation, backfill, concrete masonry, concrete reinforcement, and construction joints required for electrical work is included under this section and shall conform to requirements specified under applicable sections of Contract for General Construction.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION AND CONSTRUCTION

- A. General
  - 1. In general, any or all existing electrical equipment and services are to remain in operation and shall not be disturbed unless otherwise noted in these Specifications and/or on the Plans or as required for the proper execution of the work.
  - 2. Maintain existing electrical services and systems to and throughout the project and all “down-time” shall be scheduled at least two weeks in advance with the

permission of the Project Manager and such scheduling shall be rigidly adhered to.

3. Plans and specifications are typical of work to be done and of the arrangement desired. Provide accessories and appurtenances which the Engineer deems functionally necessary for a complete installation, whether or not explicitly indicated or described.
4. Level and plumb all equipment. All junction boxes, equipment enclosures, raceways, etc. mounted on water-bearing or earth-bearing walls or other surfaces to be separated from the surface not less than ¼-inch by corrosion-resistant spacers.
5. Install pipe caps for conduits marked "spare" and capped bushings for conduits marked "telephone." Leave a nylon pull wire (200# tensile strength) in each spare conduit. Allow 12 inches minimum of slack at each end.
6. Identification
  - a. For more information on requirements covering identification of equipment, wiring, and panels see Section 16195 - "Electrical Identification."
  - b. Proper identification of equipment and devices to include tag numbers as shown on Plans, and/or in Specification Sections.

**B. Rigid Steel Conduit - Above Ground - Indoors - Dry Locations**

Rigid steel conduit, fittings, and bodies shall be installed per Sections 16111 - "Conduit, Fittings, and Bodies" and 16402 - "Underground Duct Banks."

**C. Rigid Aluminum Conduit - Above Ground - Exposed Outdoors, Wet or Damp Locations**

Rigid aluminum conduit, fittings, and bodies shall be installed per Sections 16111 - "Conduit, Fittings, and Bodies" and 16402 - "Underground Duct Banks."

**D. Conduits - In Concrete Construction**

Conduit, fittings, and bodies shall be installed in concrete construction per Sections 16111 - "Conduit, Fittings, and Bodies" and 16402 - "Underground Duct Banks."

**E. Conduits - Below Ground**

Conduit, fittings, and bodies shall be installed below ground per Sections 16111 - "Conduit, Fittings, and Bodies" and 16402 - "Underground Duct Banks."

**F. Wire and Cable**

1. Size:  
Not smaller than 12 AWG, except control wire to be minimum 14 AWG stranded.
2. Color Coding:  
Provide color coding as follows unless otherwise specified by local ordinances:
  - a. Single phase, 120/240 volts - Red (L1), Black (L2), White (N)
  - b. Three phase 120/240 volts - Black (Phase A), Orange (Phase B) Blue (Phase C), Gray (Neutral)
  - c. Three phase, 120/208 volts - Black (Phase A), Red (Phase B), Blue (Phase C), White (Neutral)
  - d. Three phase, 480/277 volts - Brown (Phase A), Purple (Phase B), Yellow (Phase C), Gray (Neutral)
  - e. Control conductors - red
  - f. Ground wire - green
3. Where factory color-coded wire is not available, a 1-inch band of colored Scotch tape or equal may be used near the ends of each conductor. Conductors smaller than No. 8 are not to be taped for color-code.
4. Use Polywater J lubricant to pull all wires
5. Make all splices and terminations in boxes and only where shown on Plans. Size per boxes NEC.
6. No splices to be made underground
7. Use compression type lug connectors on all motor connections and at other equipment subject to vibration.
8. Use compression type connectors on all other connections involving conductors 6 AWG and larger.
9. Use spring lock connectors where compression types are not specified.
10. Do not install more than two 120/240 volt circuits or one 480 volt circuit in one conduit unless indicated otherwise on Plans.
11. Remove all burrs and swab conduits clean before pulling in wiring.
12. Do not exceed maximum pulling tension or sidewall pressure when installing cable.



13. Terminate stranded wiring by use of lugs or pressure type connectors. Do not terminate stranded wiring by wrapping stranded wire around terminals.
14. Ground shielded cable only at one point, i.e., at the panel, if possible or as recommended by manufacturer of device which shielded cable is connected to. Shields to be continuous throughout the length of the wiring run.
15. Mark all instrumentation and control wiring at each end of a run. Use Brady or approved equal adhesive wire markers.
16. Use cable tags to tag all main and feeder cables in all pull boxes, wireways, wire gutters, panels, and motor control centers. Identify wire or cable number and equipment served.
17. Leave sufficient length on all spare cables and wires to make a connection anywhere within an enclosure. Terminate with insulating tape and tag with a cable tag.

**G. Junction and Pull Boxes**

1. Install where shown on the Plans and elsewhere as required to facilitate installation of the wiring system.
2. Plug all unused openings with suitable conduit plug equal to Crouse-Hinds Type PLG.
3. Install in concrete so that the front edge shall not set back of the finished surface more than 1/4-inch.
4. Provide adequate supports.
5. Install so that covers are accessible for easy removal.
6. Provide enclosures rated for NEMA 4 with breather and drain for outdoor installations.

**H. Light Switches and Receptacles**

1. Install at the approximate locations shown on Plans
2. Light switch mounting height to be 4 feet, 6 inches above finished floor unless otherwise noted.
3. Receptacle mounting height to be 18 inches above finished floor in office and laboratory areas, 8 inches above all counters, 4 feet, 6 inches in all other places unless special mounting height is required by equipment being served or unless otherwise noted.

4. Install in nonmetallic weatherproof boxes with weatherproof covers in chlorine or chlorine storage rooms.

I. Panelboards

1. Surface mounted as indicated on Plans
2. Provide spare conduits stubbed out for future use, as indicated on Plans.
3. Mounting height to be 3 feet from floor to bottom of panel. Mount lower than this height only if necessary to have top breaker no more than 6 feet, 6 inches above finished floor.
4. Type in all circuits on the panel directory card immediately prior to job completion.

J. Grounding

1. Furnish a grounding system as required by the NEC and as further described herein.
2. Ground all electrical equipment, lights, receptacles, etc., with a separate equipment ground wire or a continuous metallic raceway system.
3. Install grounding system electrically and mechanically continuous throughout. Do not bond to the system neutral except at the service entrance.
4. Ground transformer neutrals to their housing, and bond the housing to the equipment grounding conductor.
5. Connect equipment grounding conductors to ground bars or buses provided at panelboards, motor control centers, disconnect switches, switchgear, etc., from which the equipment is served. Install a bonding jumper from the grounding lug on each conduit to the ground bar or bus.
6. Where the equipment has no facility to attach an equipment ground wire, use a Burndy Quicklug or equal. Clean the metal surface under the lug to bright metal so that good contact can be made.
7. Connect equipment grounds to motors using a grounding stud threaded into the stationary frame of the motor in the motor junction box.
8. Make ground connections to equipment by using ground lugs or ground bars where they are provided. Do not make connections to equipment anchor bolts.
9. Use a fusion process, Burndy Thermoweld, Cadweld, or equal, to make connections to ground rods and at any joint or connection which shall be inaccessible after construction.

10. Install ground cable loops at least 2 feet away from the structure and 2 feet, 6 inches below grade.
11. Use ground clamps where grounding bushings are not specified. Use copper clamps on copper, brass, or lead pipe. Use galvanized iron on galvanized or iron pipe.
12. Furnish bonding jumpers as shown or as otherwise required by the NEC. Use stranded copper wire.
13. Coat fusion-welded connections with Kopper Bitumastic No. 505 or equivalent coal tar pitch.
14. Provide a PVC sleeve where ground wire passes through concrete slab.
15. Install sufficient ground rods and wiring so the resistance between metal equipment or structural members and ground is 5 ohms or less.
16. Exposed grounding conductors to be insulated.
17. Connect ground wires entering outlet boxes in such a manner that removal of the receptacle shall not interrupt the continuity of the grounding circuit.
18. Connect each motor control center ground bus to the grounding system in at least two locations.
19. Grounding conductor to be same size as phase conductor if required by local code in any part of circuit routed in nonmetallic conduit.
20. Grounding Electrode System (GES) to be provided in compliance with NFPA 70 (NEC) Article 250 and in accordance with the following.
  - a. Metal underground water pipe, metal building frame, concrete-encased electrode, and ground ring to be utilized when available per NFPA 70 (NEC) Article 250.
  - b. In addition to items previously listed, a ¾-inch-diameter copper-clad ground rod with 10-foot minimum length to be installed as part of GES per NFPA 70 (NEC) Article 250

**3.04 DEFECTIVE OR DAMAGED EQUIPMENT:**

- A. Damaged equipment shall not be used. Equipment damaged in shipment, storage, installation or through other means shall be replaced without additional cost to the Authority.
- B. All equipment showing signs of water damage shall be rejected regardless of dielectric test results.

- C. All electrical equipment is considered “in storage” regardless of location until first energized. Manufacturer’s recommendations for storage precautions, conditions and care shall be followed.

3.05 FIELD QUALITY CONTROL

A. General

1. Provide all equipment and labor required for calibration, setting, and testing as described herein or otherwise required. All tests to be witnessed by the Project Manager and Engineer. Give written notification of the tests at least 7 days prior. Repair or replace all defective material, equipment, or workmanship disclosed as a result of these tests at no cost .
2. Starting Equipment Data List:
  - a. Obtain data from the equipment supplier shop drawing submittals or equipment nameplates, and prepare a complete tabulation of all motors over 1/3 hp, electric heaters over 3 kW, and starting equipment for both, to be furnished on the project.
  - b. Include the following in tabulation form:
    - (1) Name and identification of equipment
    - (2) Manufacturer
    - (3) Horsepower or kilowatt rating
    - (4) Voltage
    - (5) Phase
    - (6) Speed
    - (7) Full load current
    - (8) Locked rotor current or code letter
    - (9) Type of enclosure (open drip-proof, totally enclosed, fan cooled, etc.
    - (10) NEMA size of starter or contactor
    - (11) Overload heater size
    - (12) Type of starter (full-voltage, reduced-voltage, autotransformer, etc.)
    - (13) Breaker trip setting or fuse size

- (14) Voltage of starter operating coil
  - (15) If starter is at a motor control center, list motor control center number.
- B. Final acceptance of the electrical system is contingent upon submittal of the complete motor and electric heater tabulation.
- C. Records
1. Provide the Project Manager with a written record of all tests, including the piece of equipment tested, the date tested, weather conditions, test values, and results.
  2. Arrange tabulation in groups by MCC or building location.
  3. Furnish six copies of the tabulation to the Project Manager when a submission is made.
- D. Megger Tests
1. Use a minimum 500-volt megohmmeter
  2. Take each reading for at least one minute
  3. Include the following tests:
    - a. 115-volt and 230-volt motors: 5.0 megohms
    - b. 460-volt motors: 7.0 megohms
    - c. 480-volt transformer windings: 100.0 megohms
    - d. 600-volt wiring up to 1,000 ft.: 25.0 megohms
  4. Test all transformer windings as follows:
    - a. Primary to ground
    - b. Secondary to ground
    - c. Primary to secondary
- E. Ground Testing
1. Take ground resistance measurements in normally dry weather, not less than 48 hours after rainfall, with the ground under test isolated from other grounds.

2. Measure the resistance of each ground rod. Submit in writing to the Project Manager a record indicating the rod location, the resistance measures, and the soil condition at the time.
3. Take ground resistance measurements on the building water service when used as a ground.
4. Install additional grounding if the resistance to ground measures more than 5 ohms at any location.

F. Motors

1. Megger test motors per paragraph 3.05.C
2. Dry out any wet insulation by use of space heaters or other approved methods.
3. Check coupling alignment, shaft end play, lubrication, and other mechanical checks as required. Follow manufacturer's instructions.
4. Check for proper rotation

G. Receptacles:

Test all receptacles for proper connections and grounding. Use an approved plug in tester, Hubbell 5200, Woodhead 1750, or equal.

H. Control Circuits

1. Check all circuits for continuity, proper connection, and proper operations.
2. Set all time-delay relays and timers for the desired operation. Record the settings indicating the relay or timer, its location, and the setting used. Verify all settings with a stopwatch.

I. Lighting

1. Install lighting fixtures in accordance with fixture manufacturer's written instructions and recognized industry practices.
2. Fasten fixtures securely to structural support members. Ensure that all fixtures are plumb or level.
3. Testing:
  - a. Upon completion of installation of lighting fixtures and after circuitry has been energized, apply electrical energy to demonstrate proper operation of lighting fixtures and controls.
  - b. Install all new incandescent lamps just prior to final inspection. Replace gaseous discharge and fluorescent lamps that are defective,

show discolorations, or have exceeded more than 1/3 of their rated life with new lamps for final inspection.

- c. Immediately before final inspection thoroughly clean all fixtures inside and out, including plastics and glassware, adjust all trim to properly fit adjacent surfaces, replace broken or damaged parts and lamp, and test all fixtures for electrical and mechanical operation

3.06-3.10 (NOT USED)

END OF SECTION