

SPECIFICATIONS - DETAILED PROVISIONS
Section 16010 - General Electrical Requirements

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SECTION 16010
GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

Contractor shall provide all the materials and equipment, and perform all work necessary for the complete execution of the electrical work as indicated on the Drawings, as specified herein, and as specified in other Specification Sections. Miscellaneous appurtenances are not necessarily specified or indicated on the Drawings. Contractor shall provide all labor and materials not specifically indicated on the Drawings or specified in these Specifications, yet required to ensure proper and complete operation of all systems.

This Section summarizes the general requirements for electrical work, and forms a part of all other Sections of these Specifications, unless otherwise specified.

1.02 QUALITY ASSURANCE

A. General

1. It is the intent of these Specifications and the Drawings, to secure highest quality in all equipment and materials, and to require first-class workmanship, in order to facilitate trouble free operation and minimum maintenance of the electrical system.
2. All work, including installation, connection, calibration, testing and adjustment, shall be performed by qualified, experienced personnel who are technically skilled in their trades, are thoroughly instructed, and are competently supervised by a certified electrician in the state of California. The resulting complete installation shall reflect professional quality work, employing industrial standards and methods. Any and all defective material or inferior workmanship shall be corrected immediately to the satisfaction of the District and at no additional cost to the District.
3. All equipment and materials shall be new, listed by UL and bearing the UL label, unless exception to this requirement is inherent to an individual item specified herein, or exception is otherwise specified, or approved by the District.

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4. Equipment and materials shall be the products of reputable, experienced manufacturers. Singular items in the project shall be the products of the same manufacturer. All equipment and materials shall be of industrial grade and heavy duty construction, shall be of sturdy design and manufacture, and shall be capable of long, reliable, trouble-free service.
5. Contractor shall furnish manufacturer's electrical equipment of the types and sizes specified which has successfully operated for not less than the past two years, except where specific types are named by manufacturer and catalog number or designation under other Sections of the Contract Documents.

B. Environmental Sustainability

1. All electrical equipment and their enclosures shall be suitable for operation in the ambient conditions and area classification designations associated with the locations designated in the Contract Documents.
2. All electrical equipment shall be capable of operating successfully at full-rated load, without failure, when the ambient temperature of the air is 50°C. Unless specified otherwise or indicated otherwise on the Drawings, heating and cooling devices shall be provided in order to maintain all electrical equipment and instrumentation devices to within a range equal to 20 percent above the minimum and 20 percent below the maximum of the rated environmental operating ranges. All power wiring and temperature controls for these devices shall be provided by the Contactor.

C. Factory Tests

Factory tests are required for all electrical equipment and assemblies applicable to the specific project. Perform factory tests in accordance with the requirements of the particular equipment specification sections and in accordance with the codes and standards specified as applicable to the equipment. Items to be factory tested shall include, but not be limited to:

1. Motor Control Centers
2. Electrical Service Switchboards and Distribution Switchboards
3. Variable Frequency Drives
4. Solid State Starters
5. Automatic Transfer Switches

6. Manual Transfer Switches
7. Induction Motors
8. Emergency Generators
9. Custom Control Panels
10. Programmable Logic Controllers
11. Instrumentation and Controls

D. Codes and Standards

Provide electrical equipment and materials, including installation, conforming to the following codes and standards, as applicable. The equipment and materials shall bear labels to indicate manufacturing conformance to the specified standards, or equal.

1. American National Standards Institute (ANSI)
2. California Energy Commission (CEC), Title 24
3. Institute of Electrical and Electronic Engineers (IEEE)
4. National Electrical Manufacturers Association (NEMA)
5. Underwriters' Laboratories (UL)
6. Edison Testing Labs (ETL), Intertek Testing Services NA, Inc.
7. Factory Mutual (FM)
8. Insulated Power Cable Engineers Association (IPCEA)
9. American Society for Testing and Materials (ASTM)
10. NFPA 70 - National Electrical Code (NEC)
11. National Fire Protection Association (NFPA) 820- Standard for Fire Protection in Wastewater Treatment and Collection Facilities
12. Occupational Safety and Health Regulations of Occupational Safety and Health Administration (OSHA)

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13. City and State Electrical Codes. Applicable portions of local and state codes.
14. Serving Utility Company (service, metering and interconnection requirements)
15. South Coast Air Quality Management District (SCAQMD)
16. National Institute of Standards and Technology (NIST)
17. National Electric Testing Association (NETA)
18. National Electrical Safety Code (NESC)
19. Certified Ballast Manufacturers Standards
20. Illuminating Engineering Society Handbook Standards
21. Basic Electrical Regulations, Title 24, State Building Standards, California Administrative Code
22. Low Voltage Electrical Safety Orders, Title 8, Division of Industrial Safety, State of California

Underwriters' Laboratories Approval: All equipment furnished by the Contractor shall be listed by and shall bear the label of Underwriters' Laboratories, Incorporated (UL), or Edison Testing Labs (ETL), or of a Nationally Recognized Testing Laboratory (NRTL) acceptable to the District.

Where the Drawings or these Specifications call for equipment and workmanship to be of better quality of higher standard than required by the above codes, standards, rules, and regulation, then said Drawings and Specifications shall prevail. Nothing on the Drawings or in these Specifications shall be construed to permit work in violation of the above codes, standards, rules, and regulations and the Contractor shall be held responsible for any work which is not acceptable.

In case of conflict or disagreement between building codes, state law, local ordinances, industry standards, utility company regulations, Drawings and Specifications, or within the Contract Document itself, the most stringent condition shall govern. The Contractor shall promptly notify the District in writing of such differences.

1.03 UTILITY COMPANY REQUIREMENTS

- A. Unless specified otherwise, the District will make application for electric and telephone service (if applicable). The District will pay utility company connection fees for permanent service. Fees for temporary service during construction shall be paid by the Contractor.
- B. All work for electrical power shall be performed in accordance with the requirements of the respective serving utility companies.
- C. Immediately after the award of the contract, the Contractor shall notify the serving utilities that the project is under construction and provide them with all pertinent information, including the dates on which the services will be required.
- D. Shop drawings shall be submitted to the power utility company with the appropriate panel dimensions (top view and elevation view) and EUSERC (Electric Utilities Service Equipment Requirement Committee) No. for service entrance and metering sections (electrical service switchboard), unless indicated otherwise on the Drawings. The power utility company serving the District is Southern California Edison (SCE).
- E. Contractor shall coordinate details and timing of service switchboard installation with SCE, provide all required temporary service, and include all utility connection fees for temporary service in his bid proposal. In addition, all coordination and fees associated with obtaining from SCE the maximum available short circuit current at the secondary side of the service transformer shall be obtained by the Contractor.

The District will “Green Tag” the service when all SCE requirements and NEC grounding requirements are met. Contractor shall provide the services of an independent testing consultant for all testing required to Green Tag the service, as specified herein and in Section 16040.

- F. Where indicated on the Drawings, the Contractor shall construct new electrical services per SCE requirements, the SCE Service Plan, and in accordance with the Contract Documents. Contractor shall furnish and install all facilities as required by the SCE Service Plan and as indicated on the Drawings. Facilities may include conduits, intercept box, transformer pad, slab box, service switchboard, and associated appurtenances. SCE will furnish and install the service transformer and conductors from utility power location to transformer, and from transformer to service meter. Copies of the SCE Service Plan (if available) are attached in Special Conditions or in an Appendix to these Specifications.
- G. Contractor shall install telephone service entrance conduit, backboard, receptacles, grounding, and other telephone equipment indicated on the Drawings in accordance with the serving utility's requirements.

1.04 SUBMITTALS

A. General

Contractor shall provide submittals (shop drawings) in accordance with the requirements of the District's General Conditions, and as specified herein and in other Sections of Division 16. Shop drawings shall be submitted for the following items:

1. All electrical equipment and materials including conduit, conductors, pull boxes, junction boxes, and appurtenances.
2. Switchboards, panelboards, motor control centers, variable frequency drives, terminal cabinets, transformers, and other major equipment or apparatus.
3. Control panels and other specially-fabricated or custom-made equipment.
4. Other items as may be specifically called for herein or per other Sections of the Specifications.

B. Shop Drawings

1. Submit a complete list of all materials, equipment, apparatus, and fixtures; including manufacturer's product literature and data; clearly indicating which equipment, materials, accessories, etc. the Contractor proposes to use. The list shall include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
2. Contractor shall submit detailed dimensioned shop drawings of all designated equipment for District's review before fabrication. Drawings submitted for review shall include front views, top and bottom views, internal elevation views, sections, and anchoring details. Separate drawings shall be submitted for control and wiring diagrams. Wiring diagrams shall be provided for all electrical equipment furnished, except lighting. Shop drawings shall be checked by the Contractor before submittal for review by the District, and the Contractor shall certify that the submittals are in accordance with the Drawings and Specifications. Should an error be found in a shop drawing during installation of equipment, the correction, including any field changes found necessary, shall be noted on the drawings, and the as-built drawings shall be provided with the final equipment operation and maintenance manuals.

3. Manufacturer catalog literature, bulletins, brochures or the like shall be submitted for all materials and equipment. This data shall be submitted together with a clear indication (arrows) of the specific item or items, or class of items proposed, in order to establish written record of the Contractor's intent. A list of items indicating "as specified" will not suffice. A manufacturer's name alone will not suffice. Each sheet of descriptive literature submitted shall be clearly marked by the Contractor to identify the material or equipment as follows:
 - a. Lamp fixture descriptive sheets shall show the fixture schedule type for which the sheet applies.
 - b. Equipment and materials descriptive literature and drawings shall indicate the Specification Section and Subsection for which the equipment and/or materials applies.
 - c. Sheets or drawings showing more than the particular item under consideration shall have crossed out all but the pertinent description of the item for which review is requested.
 - d. Equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications shall be identified by a suitable notation.
 - e. Schematic, wiring, and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections. Connection diagrams shall indicate field installed equipment with the specified drawing device number or name as illustrated on the Construction Drawings and submitted shop drawings.
4. Submit data for earthquake (seismic) design and restraint with the shop drawing submittals for all switchboards, panelboards, motor control centers, variable frequency drives, and control panels. Anchorage data and details shall be provided for same. Calculations and details shall be stamped by a California registered "Civil" or "Structural Engineer." Refer to Special Conditions and Section 11005 for special seismic design requirements.

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C. As-Built Drawings

Contractor shall prepare, maintain, and submit as-built Drawings in accordance with the District's General Conditions, and as specified herein.

At the completion of the Work, Contractor shall furnish the District with three (3) final sets of as-built electrical Drawings marked with any changes, deviations or additions to any part of the electrical work. During construction, one (1) red-lined set of as-built Drawings shall be maintained at the job site by the Contractor until the final as-built Drawings are received by the District.

Contractor shall clearly indicate on the as-built Drawings the following information:

1. All conduit runs as actually installed.
2. Location of all underground conduits and stub-outs accurately dimensioned.
3. Forming, cabling, and identification of all power and control conduit and wiring within manholes, pull boxes, junction boxes, and terminal boxes.
4. Interior views of each manhole and pull box identifying each conduit entrance by conduit number.
5. All changes, deviations, or additions to any part of the electrical work, including, but not limited to: locations, routing, dimensions, wiring, or connections.

D. Operation and Maintenance Manuals

Contractor shall provide operation and maintenance (O&M) manuals for all electrical equipment in accordance with District's General Conditions, Section 01430, and as specified herein.

The manuals shall include all system drawings, block diagrams, single line and control diagrams, wiring schematics, loop diagrams, shop drawings, manufacturer product literature and data for supplied equipment and other pertinent data required to completely describe the operation and maintenance of the installed electrical system.

These manuals shall be submitted prior to final acceptance of the system and shall reflect all as-built conditions.

As a minimum, the electrical system information in the O&M manuals shall contain:

1. System operating instructions written for the benefit of the District's operating personnel for normal operational condition and utilizing names of controls as they appear on nameplates.
2. Installation instructions.
3. Pre-energizing, energizing, and de-energizing procedures.
4. Maintenance instructions.
5. Troubleshooting instructions.
6. Calibration instructions.
7. Instructions for ordering replacement parts.
8. Part List
 - a. List of fuses, lamps, and other expendable equipment and devices with manufacturer names and part numbers.
 - b. List of all vendors, addresses, and phone numbers.

E. Miscellaneous Reports

Contractor shall submit all other reports as called for in these Specifications at the times specified. These miscellaneous reports include, but are not limited to, test procedures, records of electrical test results, and manufacturer certificates of inspection.

F. Manufacturer's Certified Reports

Each equipment manufacturer, or his authorized representative, shall submit a written report with respect to his equipment certifying the following:

1. Pre-Startup Complete
 - a. The equipment has been properly installed, wired, and connected in accordance with the manufacturer's requirements.
 - b. The equipment is in accurate alignment.

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- c. Manufacturer has checked, inspected, and adjusted the equipment as necessary.
2. Startup and Field Testing Complete
 - a. Manufacturer was present when the equipment was placed into operation.
 - b. The equipment has been operated under full load conditions and operated satisfactorily.
 - c. All field testing, including operational demonstration and system validation testing, has been completed and equipment performed satisfactorily throughout each test.
 - d. The equipment is fully covered under the terms of the guarantee.

G. Electrical Short-Circuit/Coordination Study, Arc-Flash Hazard Study, and Testing Report

In accordance with Section 16040, Contractor shall submit electrical short-circuit/coordination study, arc-flash hazard study, and testing report certifying proper setting of all protection devices, ground testing, and arc-flash hazard labeling.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery

Contractor shall require that all electrical materials and equipment be shipped and delivered in accordance with the manufacturer's requirements. Deliver electrical materials and equipment in manufacturer's original cartons or containers with seals intact, as applicable. Unless specified otherwise, deliver conductors in sealed cartons or on sealed reels, ends of reeled conductors factory sealed. Deliver large multicomponent assemblies in sections that facilitate field handling and installation.

B. Handling

Contractor shall unload and handle materials and equipment in accordance with manufacturer's recommendations. Lift large or heavy items only at the points designated by the manufacturer. Use padded slings and hooks for lifting as necessary to prevent damage.

C. Storage

Store electrical equipment and material in accordance with the manufacturer's requirements. Where enclosures are specified to be provided with space heaters, Contractor shall furnish temporary power to equipment space heaters to prevent condensation until the equipment is installed and energized.

Unless designed for outdoor exposure, store electrical materials off the ground and under cover to prevent corrosion, contamination, or deterioration.

1.06 COORDINATION OF WORK AND TRADES

- A. Electrical work shall conform to the construction schedule and progress of other trades. The electrical construction shall be performed in cooperation with all other trades so that a neat and orderly arrangement of the work as a whole shall be obtained.
- B. Electrical components on all equipment shall be handled, set in place, connected, checked out, serviced, and placed in readiness for proper operation to the satisfaction of the District all within the scope of work intended under this Section.
- C. Before any work is commenced, Contractor shall verify with the equipment manufacturers that equipment dimensions and arrangements will allow for equipment installation in the spaces provided for on the Drawings, including, but not limited to: all switchboards motor control centers, variable frequency drives, panelboards, control panels, terminal cabinets, transformers, and other items of electrical equipment or apparatus; and that the installation spaces indicated will provide for all required ventilation, clearances, access, and work space.
- D. Before installing any equipment, conduit, or materials, the Contractor shall examine the complete set of Contract Documents (Drawings and Specifications) and approved shop drawings, and confirm all dimensions and space requirements.

1.07 COORDINATION OF THE ELECTRICAL SYSTEM

- A. Contractor shall verify all actual equipment and motor full-load and locked rotor current ratings. The necessary minimum equipment, conductors, and conduit sizes are indicated on the Drawings. If the Contractor furnishes equipment of different ratings, the Contractor shall coordinate the actual current rating of equipment furnished with the branch circuit conductor size, the controller size, the motor starter, and the branch circuit over current protection. The branch circuit conductors shall have a carrying capacity of not less than 125% of the actual full-load current rating. The size of the branch circuit conductors shall be such that the voltage drop from the overcurrent protection devices up to the equipment shall not be greater than 2% when the equipment is running at full load and rated voltage. Conductor ampacities shall be derated in accordance with NEC, Table 310-16 for ambient temperatures of 114-122°F.
- B. Unless specified otherwise, the motor running solid state overcurrent protection devices shall be ambient temperature compensated for 50°C and be rated or selected to trip at no more than 125% of the motor full-load current rating for motors marked to have a Class B temperature rise not over 80°C or motors marked with a service factor not less than 1.15, and at no more than 115% for all other types of motors.
- C. Unless specified otherwise, the motor branch circuit overcurrent protection device shall trip open in 10 seconds or less on locked-rotor current of the motor. This device shall also protect the motor branch circuit conductors and the motor control apparatus against overcurrent due to short circuits or ground faults. The motor control circuits shall have overcurrent protection of the type specified in the Specifications, or indicated on the Drawings.

1.08 RELATED WORK SPECIFIED ELSEWHERE

- A. The Contract Documents are a single integrated document, and as such all Specification Divisions and Sections apply. It is the responsibility of the Contractor and its Subcontractors to review all sections to ensure a complete and coordinated project.
- B. Related Specification Sections include, but are not limited to, the following:
 - 1. Sections of the Specifications specifying equipment and/or systems requiring electrical power and/or control.
 - 2. Division 16 – Electrical
 - 3. Division 17 – Instrumentation and Controls

1.09 PERMITS

Contractor shall obtain and pay for all permits, licenses, and inspections required for electrical construction work by public agencies and utility companies having jurisdiction, except as otherwise specified.

1.10 OUTAGES

- A. Contractor shall keep equipment system power outage periods to the minimum time feasible, and only for such times and durations as may be approved by the District. Contractor shall submit any request for an equipment system power outage (shutdown) in writing to District for approval at least 10 working days in advance of said shutdown. The written request shall include the date, time, location, affected equipment and systems, and proposed duration of the shutdown. Contractor shall bear all overtime costs for outages required to be performed during non-working hours.
- B. Contractor shall keep facility power outage periods to the minimum time feasible, and only for such times and durations as may be approved by the District and SCE. Contractor shall submit request for a facility power outage (shutdown) in writing to District for approval at least 45 working days in advance of said shutdown. The written request shall include the date, time, location, and proposed duration of the shutdown. If the proposed facility shutdown is approved by the District, Contractor shall provide all necessary coordination with SCE and the District throughout the planning and shutdown period. Contractor shall bear all overtime costs for facility outage required to be performed during non-working hours.

1.11 AREA CLASSIFICATION DESIGNATIONS

A. General

For purposes of defining electrical enclosure and electrical installation requirements, certain areas have been classified in this Section, other Specification Sections, or indicated on the Drawings. Electrical equipment, materials, and installations within these areas shall conform to the equipment standards and code requirements for the areas involved.

B. Indoor Locations

Unless specified otherwise, electrical work installed in indoor, dry, non-corrosive areas that are not subject to wash down and not specifically classified shall be general purpose locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in general purpose locations shall be rated NEMA 12. Enclosures for motor control centers, switchboards, panelboards, and variable frequency drives in general purpose locations shall be rated NEMA 1A (gasketed).

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C. Outdoor Locations

Unless specified otherwise, electrical work installed in indoor areas subject to wash down or installed in outdoor areas shall be classified as wet locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in wet locations shall be rated NEMA 4X. Enclosures for motor control centers, switchboards, panelboards, and variable frequency drives in wet locations shall be rated NEMA 3R (weatherproof). Wherever possible, outdoor enclosures shall be gasketed, and shall be provided with hinged and padlockable doors.

D. Corrosive Locations

Unless specified otherwise, electrical work installed in indoor or outdoor areas with exposure or potential exposure to chemical liquids, chemical gases, sewage, or sludge shall be classified as corrosive locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in corrosive locations shall be rated NEMA 4X. Wherever possible, NEMA 4X enclosures shall be constructed of Type 316 stainless steel, and shall be provided with hinged and padlockable doors.

E. Hazardous Locations

Unless specified otherwise, electrical work installed in indoor or outdoor areas with exposure or potential exposure to flammable gases or vapors, or combustible dusts shall be classified as hazardous locations. Enclosures for instruments, control panels, controllers, terminal cabinets, junction boxes, devices, etc., in hazardous (classified) locations shall be provided in accordance with NEC Articles 500 through 504.

1.12 WARNING SIGNS

- A. Unless specified otherwise, permanent warning and caution signs shall be mounted at the site and on all mechanical equipment which may be started automatically or from remote locations for personnel safety. Signs shall be fabricated in accordance with Porcelain Enamel Institute Specification S-103 and shall be suitable for exterior use. Mounting details shall be in accordance with the manufacturer's recommendations. Signs shall be located as approved by District. Provide a minimum of one (1) sign at each equipment location.
- B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

**CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL**

- C. Where specified, provide a minimum of one (1) sign mounted on the entrance door of generator, blower, or compressor rooms. Sign shall read:

**CAUTION
HEARING PROTECTION
SHALL BE WORN IN THE
AREA**

- D. Permanent and conspicuous warning signs shall be mounted on all equipment and doorways to equipment rooms where the voltage exceeds 600 volts.
- E. Where specified, provide a minimum of one (1) sign mounted on the door of pump or electrical rooms. Warning signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18 gage vitreous enameling stock. Sign shall read:

**WARNING
HIGH VOLTAGE
AUTHORIZED PERSONNEL ONLY**

1.13 GUARANTEE AND WARRANTY

Contractor shall guarantee all work of Division 16 in accordance with the General Conditions. With respect to equipment, guarantee shall cover (1) faulty or inadequate design; (2) improper assembly or erection; (3) defective workmanship or materials; and (4) incorrect or inadequate operation, or other failure. For equipment bearing a manufacturer's warranty in excess of one (1) year, furnish a copy of the warranty to the District, who shall be named as beneficiary.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

Contractor shall provide new materials and equipment as required to complete all indicated and specified electrical work, including incidental items inferable from the Contract Documents that are necessary to complete the work. Provide materials and equipment of latest design, standard products of established manufacturers. Custom products shall be provided where required to comply with specified performance requirements or special features and capabilities.

For uniformity, only one manufacturer is acceptable for each type of product. Manufacture individual parts to standard sizes and gages so repair parts can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not be placed in service at any time prior to delivery, except as required for factory or shop tests.

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A. Prohibited Materials

Aluminum conductors are not acceptable.

B. Damaged Products

Notify the District in writing if any equipment or material is damaged. Do not repair damaged products without prior written approval.

C. Factory Finishes

Unless specified otherwise in other Division 16 Sections or in the Special Conditions, the sheet metal surfaces of equipment enclosures shall be phosphatized and coated with a rust resisting primer. Over the primer, apply a corrosion resistant baked enamel finish on the interior and exterior metal surfaces. The exterior color shall be ANSI No. 49 medium light gray. The interior color shall be white. Hardware shall have a corrosion resistant finish. Sheet metal enclosures and lighting fixtures, in corrosive areas, shall have an outer coating of corrosion resistant epoxy.

PART 3 - EXECUTION

3.01 GENERAL

Contractor shall install electrical work in accordance with the codes and standards specified, except where more stringent requirements are indicated or specified. Prior to commencing construction, Contractor shall verify that equipment and materials properly fit the installation space with clearances conforming to the codes and standards specified, except where greater clearance is indicated. Contractor shall perform work as required to correct improper installations, at no additional cost to the District.

3.02 ELECTRICAL SUPERVISION

In addition to supervision required under the General Conditions, Contractor shall assign a competent representative to supervise the electrical construction work from beginning to completion and final acceptance.

3.03 INSPECTION

Contractor shall inspect each item of equipment and material for damage, defects, completeness, and correct operation before installing. In addition, Contractor shall inspect previously installed related work and verify that it is ready for installation of electrical work.

3.04 PREPARATION

Prior to installing electrical work, Contractor shall ensure that installation areas are free of debris and clean. Contractor shall maintain the areas in a broom-clean condition during installation operations. Contractor shall clean, condition, and service equipment in accordance with the manufacturer's instructions, approved submittals, and other requirements indicated or specified.

3.05 WORKMANSHIP

Contractor shall employ skilled craftsmen experienced in installation of the types of electrical equipment and materials specified. Contractor shall use specialized installation tools and equipment as applicable. Contractor shall construct acceptable installations free of defects. Refer to Part 1.02 herein.

3.06 PROTECTIVE DEVICE ADJUSTMENTS

Contractor shall adjust all protective devices in accordance with tabulated settings listed in the approved coordination study per Section 16040. In addition, adjustments shall conform to SCE requirements and IEEE Standard 242. No equipment shall be operated prior to said adjustments being properly completed and field verified/tested.

3.07 JOB SITE CONDITIONS AND ELECTRICAL DRAWINGS

A. Job Site Conditions and Drawings

1. The Drawings indicate diagrammatically the desired location and arrangement of outlets, conduit runs, equipment, and other items. Exact locations shall be determined in the field based on the physical size and arrangement of equipment, finished elevations, and obstructions. Locations indicated on the Drawings, however, shall be adhered to as closely as possible.
2. All equipment and conduit shall be installed in such a manner as to avoid all obstructions, preserving headroom, and keeping openings and passageways clear. Lighting fixtures, switches, convenience outlets, and similar items shall be located within finished rooms as indicated on the Drawings. Where these Drawings do not indicate exact locations, Contractor shall propose locations to the District for final approval by District prior to installation. Where equipment is installed without approval and must be moved (as determined by the District), it shall be moved without additional cost to the District.

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3. Allowance has been made in the design for the number of conduits, conductors and cables, which the District considers adequate for feeding various equipment and drives. These circuits and diagrams are based on available data pertaining to a particular design of equipment and portray the systems which the District has chosen to effect the required operation and level of control. Equipment provided by the Contractor (even though of the make and model specified) may differ in detail, arrangement, connections or form from that indicated on the Drawings. If the Contractor uses equipment which differs from the equipment shown in major aspects and requires modifications to power, control or other electrical systems (including, but not limited to, size and quantity changes to conductors, conduits, starters, circuit breakers, control devices, etc.), the District's acceptance of the equipment will be based upon the Contractor providing the modification required, and they shall be of the same quality as shown and shall be provided at no additional costs to the District.
4. The Drawings do not, and are not intended to, show all required equipment, such as pull boxes, junction boxes, etc. nor to indicate all mechanical or structural difficulties that may be encountered which would necessitate routing alteration, or fittings. Items not specifically mentioned in these Specifications or noted on the Drawings or approved shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.
5. Discrepancies shown on different Drawings, between Drawings and actual field conditions, or between Drawings and Specifications shall be promptly brought to the attention of the District for direction.
6. The equipment alignment and conduit shall be varied due to architectural changes, or to avoid work of other trades, without extra expense to the District.

B. Protection of Existing and New Facilities

1. Contractor shall hand dig or otherwise cautiously dig the trenches for the underground lines in areas where interferences are possible or where electric lines must pass or cross below or above existing facilities.

2. Contractor shall protect electrical equipment and materials until final acceptance by the District. Contractor shall protect factory painted surfaces from impact, abrasion, discoloration, and other damage. Contractor shall keep electrical equipment, materials, and insulation dry at all times. Contractor shall maintain heaters in equipment connected and operating until equipment is placed in operation. If partial dismantling of equipment is required for installation, box or wrap the removed parts until reinstalled. Contractor shall repair or replace damaged work as directed by the District, and at no additional cost to the District.

3.08 FIELD TESTING AND QUALITY CONTROL

A. General

1. Prior to testing equipment including wiring and cables, the equipment shall be installed and anchored in accordance with the manufacturer's recommendations and the Contract Documents. A minimum of ten (10) working days in advance of testing, Contractor shall provide written notice to the District for installation inspection. District's and equipment manufacturer's acceptance of installation shall be obtained prior to the commencement of any testing.
 - a. The District intends to observe all testing, thus, the Contractor shall prepare a testing schedule showing daily work and projecting same for a minimum of three (3) weeks. Contractor shall maintain a current testing schedule and submit updated schedules to the District on weekly intervals.
 - b. Contractor shall provide a minimum of ten (10) working days advance notice to the District for the scheduling of any testing.
 - c. Contractor shall provide the manufacturers' documentation for testing for all equipment.
 - d. In the event a retest is required due to equipment failure, adverse testing conditions, or installation deficiency, Contractor shall schedule the retest. Any impact to project schedule or testing schedule shall be borne by the Contractor.
2. Inspection and test records shall be submitted to the District no later than thirty (30) days after completion of the individual test and prior to energizing of equipment.
3. All tests shall be performed with the equipment or material de-energized, except where otherwise specifically required by the nature of the test.

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4. All items not in conformance with the requirements of these Specifications shall be corrected by the Contractor.
5. Upon completion of various phases of the project, electrical equipment and wiring and cabling systems shall be inspected and tested in accordance with this Specification. All testing shall be in accordance with the applicable ANSI, IEEE, NETA, NEMA, or other national standard, and in accordance with the specific manufacturer's instruction bulletins or other literature supplied with the equipment to be tested, and the test equipment manufacturer's operating instructions. All tests that are required to be performed, whether performed by the Contractor or by the Testing Consultant (refer to Part 3.08E herein) shall be in accordance with NETA Standard for Acceptance Testing Specifications.
6. No equipment shall be energized until the testing and setting of protective devices per Section 16040 and testing as specified herein has been completed and accepted by the District.
7. Contractor shall provide all test data in tabulated form as approved by the District. Insulation testing (high potential testing) and continuity testing data shall include conductor number, size, test value, and expected value for each conductor.
8. Contractor shall check all equipment for proper mechanical adjustment and freedom of operation. All electrical equipment, both pre-wired and field-wired shall be field-tested for functional operation, including all intended modes and sequences of operation. This shall include switches, relays, non-adjustable circuit breakers, contractors, etc., including control interlock and sequence circuits. All necessary adjustments shall be made on apparatus in accordance with the manufacturer's instructions and design requirements. Alarm systems and circuits shall be tested by manually operating initiating devices. Relays and control components that may prove to be functioning incorrectly or otherwise appear to be unreliable shall be repaired or replaced as necessary. An electrical system will not be accepted until it is tested in its entirety and the results reported to and accepted by the District.

9. Each equipment manufacturer shall furnish the services of an authorized representative especially trained and experienced in the installation of his equipment to: (1) supervise the equipment installation in accordance with the Contract Documents, approved submittals, and manufacturer's instructions; (2) inspect, check, adjust as necessary, and approve the installation prior to start up; (3) submit certification that equipment is ready to start-up and test; (4) be present when the equipment is placed into operation and tested; (5) repeat the inspection, checking, adjusting, and testing until all trouble or defects are corrected and the equipment installation and operation are acceptable; and (6) prepare and submit the specified Manufacturer's Certified Report (refer to Part 1.04F herein). Contractor shall include all costs for manufacturer representatives' services in the Contract Price.
10. All costs associated with equipment and material testing and retesting (if required) shall be paid by the Contractor.

B. Testing Power, Control, and Lighting Circuits - 600 V and Below

Contractor shall perform continuity checks of all power, control and lighting conductors and cables, including each conductor of multi-conductor and multi-pair cables. Continuity checks shall be performed prior to termination of conductors and cables, and any testing by the Testing Consultant.

1. Contractor shall visually check all conductor and cable connections, verify conductor numbers, and verify that the actual wiring conforms to the Drawings and shop drawings.
2. Each power conductor shall be tested to ensure proper phase identification.
3. The conductor ends shall be cleaned and guarded for personnel safety during testing. Circuits in the immediate vicinity that are not under test shall be grounded.
4. Contractor shall perform insulation resistance tests on all 600 V rated power conductors. Each conductor shall be tested against ground with the conduit and/or all other conductors connected to ground. Motor feeder circuits shall be tested with motors disconnected and the controller open. Lighting panelboard main feeder circuits, including lighting panelboard and transformer, shall be tested with the branch circuit breakers open. Testing shall be for one minute using 1000 V DC. Values of insulation resistance less than 50 megohms shall not be acceptable.
5. Control and lighting circuits require only functional tests.

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6. Branch lighting circuits containing light fixtures and receptacles require only functional tests.
7. Contractor shall check all AC and DC control circuits for short circuits and extraneous grounds.
8. Contractor shall perform functional tests of all power, control, and lighting circuits. Alarm conditions shall be simulated for each alarm and control point, and alarm indicators shall be checked for proper operation. All control circuits shall function as intended by the Contract Documents. Metering and indication lights for motors shall be checked for proper operation. All lighting panels, circuits, lighting fixtures, and receptacles shall be tested for proper operation.
9. The District shall be notified if minimum insulation resistance values are not obtained and if any functional tests fail.

C. Testing Instrumentation, Signal, and Alarm Circuits - 300 V and Below

1. Contractor shall perform continuity checks of all instrumentation, control, signal, and alarm conductors and cables, including each conductor of multi-conductor and multi-pair cables. Continuity checks shall be performed prior to termination of conductors and cables.
2. Contractor shall visually check all conductor and cable connections, verify conductor numbers, and verify actual wiring conforms to the Drawings.
3. Performing insulation resistance tests on conductors and cables will not be required, but functional tests shall be performed.
4. All signal and alarm conditions shall be simulated for each status, alarm and control point, and status/alarm indicators checked for proper operation, similar to that required for control circuits.
5. Contractor shall check all AC and DC instrumentation, signaling and alarm circuits for short circuits and extraneous grounds.
6. The District shall be notified if any functional tests fail.

D. Motor Testing Prior to Energization

The following tests shall be conducted prior to starting motors for all motors 5 horsepower and larger:

1. Compare equipment nameplate with the Contract Documents and approved shop drawings.
2. Inspect physical and mechanical condition.
3. Inspect anchorage, alignment, and grounding.
4. Perform insulation resistance tests in accordance with IEEE 43 of all motor windings before connecting power conductors to motors. Test duration shall be one minute. Insulation resistance shall be a minimum of 50 megohms at 20°C at test voltage of 1000 V DC.
5. Inspect bolted electrical connections for high-resistance using the calibrated torque-wrench method in accordance with manufacturer's published data.
6. Check all bearings to see if they are properly filled with oil or grease.
7. Check coupling alignment and shaft end play.
8. Rotate the motor shaft by hand or bar to ensure it is free to rotate.

E. Tests Required to be Performed by Independent Testing Consultant (Testing Consultant)

1. Subsequent to acceptance of equipment installation by the District, the Contractor shall provide a minimum of ten (10) working days written notice of independent third party testing. All terminations required for NETA testing shall be complete. Energizing of tested equipment is at the discretion of the District and will not take place until passed and documented by the Testing Consultant and reviewed by the District. The entire electrical system shall be tested before energization. If functional testing requires power, the Contractor shall provide temporary power for that purpose. All testing shall be completed prior to equipment start up.
2. All references to NETA in this Section are referring to NETA Standard for Acceptance Testing Specifications.
3. The Testing Consultant shall provide a detailed report on all testing per NETA and Section 16040 for District's approval.

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4. In addition to and in conjunction with testing and protective device setting per Section 16040, the following tests shall be performed by the Testing Consultant and witnessed by the Contractor and District:
 - a. Switchboard and Switchgear Assemblies

Perform all inspections and tests, including all optional tests, listed in Section 7.1 of NETA on all Medium-Voltage Switchboards and Switchgear, and Low-Voltage Switchboards and Switchgear.
 - b. Transformers, Dry-Type, Air-Cooled

Perform all inspections and tests, including all optional tests, listed in applicable Section 7.2.1.1 or 7.2.1.2 of NETA on all dry type transformers.
 - c. Transformers, Liquid-Filled

Perform all inspections and tests, including all optional tests listed in Section 7.2.2 of NETA on all liquid-filled transformers.
 - d. Conductors and Cables, Low-Voltage and Medium-Voltage

Perform all inspections and tests, including all optional tests, listed in Sections 7.3.2 and 7.3.3 of NETA on all low-voltage (600 V maximum) and medium-voltage conductors and cables.
 - e. Circuit Breakers, Insulated-Case/Molded-Case

Perform all inspections and tests (not including optional tests), listed in Section 7.6.1.1 of NETA on all insulated-case/molded-case circuit breakers 100 A frame and higher.
 - f. Circuit Breakers, Vacuum, Medium-Voltage

Perform all inspections and tests, including all optional tests, listed in section 7.6.3 of NETA on all medium-voltage circuit breakers.
 - g. Protective Relays, Electromechanical and Solid-State

Perform all inspections and tests, including all optional tests, listed in Section 7.9.1 of NETA on all electromechanical and solid-state protective relays.

- h. Protective Relays, Microprocessor-Based

Perform all inspections and tests listed in Section 7.9.2 of NETA on all microprocessor-based protective relays.
- i. Metering Devices, Microprocessor-Based

Perform all inspections and tests listed in Section 7.11 of NETA on all metering devices including power monitors.
- j. Grounding Systems

Perform all inspections and tests listed in Section 7.13 of NETA on all grounding systems.
- k. Ground-Fault Protection Systems, Low-Voltage

Perform all inspections and tests listed in Section 7.14 of NETA on all ground fault protection systems.
- l. Rotating Machinery, AC Induction Motors and Generators

Perform all inspections and tests, including all optional tests, listed in Section 7.15.1 of NETA on all low-voltage AC motors and generators 20 HP and larger.
- m. Motor Control, Motor Starters, Low-Voltage

Perform all inspections and tests, including all optional tests, listed in Section 7.16.1.1 of NETA on all motor starters. For item 7.16.1.1.6 "Perform operational tests by initiating control devices," the starter control devices (selector switches, pushbuttons, relays, pilot lights, etc.) and motor control wiring shall be tested by simulating field device controls or signals at starter terminal blocks to simulate actual control functionality. Control functionality shall also be checked during field operation testing as described herein, and in accordance with other Sections of the Detailed Provisions.
- n. Motor Control, Motor Control Centers, Low-Voltage

Perform all inspections and tests, including all optional tests, listed in Section 7.16.2.1 of NETA on all MCCs.

o. Variable Frequency Drives

Perform all inspections and tests, including all optional tests, listed in Section 7.17 of NETA on all Variable Frequency Drives, except for Section 7.17.2.7 which shall be performed by the manufacturer. For item 7.17.2.8 "Perform operational tests by initiating control devices, the VFD control devices (selector switches, pushbuttons, relays, pilot lights, etc.) and motor control wiring shall be tested by simulating field device controls or signals at starter terminal blocks to simulate actual control functionality." Control functionality shall also be checked during field operation testing as described herein, and in accordance with other Sections of the Detailed Provisions.

p. Emergency Systems, Automatic and Manual Transfer Switches

Perform all inspections and tests listed in Section 7.22.3 of NETA on all Automatic and Manual Transfer Switches, and Manual Bypass Switches.

q. Setting and Testing of Adjustable/Programmable Protective Devices

The Testing Consultant shall set/program and test the adjustable/programmable protective devices in the field according to applicable NETA and manufacturer's requirements and per Section 16040. Contractor shall provide all software and hardware required to set or program devices. The protective devices shall be tested for operation after completion of device setting and programming.

5. In conjunction with the NETA inspections and tests specified above, each bolted connection shall receive Dykem Orange Torque-Seal, or equal, following verification of proper bolt-torque level.

F. Operational Demonstration Testing

Contractor shall demonstrate that the performance of installed electrical materials and equipment complies with requirements specified in Division 16. Operate equipment through entire no-load to full-load range for not less than 4 hours unless a longer period is specified elsewhere. Immediately correct defects and malfunctions with approved methods and materials in each case, and repeat the demonstration. Operational demonstration testing shall conform to the approved demonstration testing plan.

G. System Validation Testing

Unless specified otherwise, test all electrical systems for not less than 7 days (168 hours), with no interruptions except for normal maintenance. System validation testing shall conform to the approved test plan. Coordinate testing with equipment validation testing required under Divisions 11 and 16, and under the Special Conditions.

1. Testing Materials and Equipment

Contractor shall furnish all labor, equipment, and materials for required tests, including all instruments, recorders, gauges, chemicals, power, etc.

2. Testing Methods

Contractor shall perform field tests on equipment as specified in the Special Conditions and/or Specification Sections for the specific equipment. Unless specified otherwise, operate systems continuously (24 hours per day) under constant supervision of trained operators and/or field service engineers. Cause variable speed equipment to cycle through the applicable speed range at a steady rate of change. Induce simulated alarm and distressed operating conditions, and test controls and protective devices for correct operation in adjusting system functions or causing system shutdown. Perform other system validation tests as may be required under other Sections of Division 11 and 16, and under the Special Conditions.

3. Defects

Contractor shall immediately correct all defects and malfunctions disclosed by tests. Contractor shall use new parts and materials as required to perform corrective work, as approved by the District. The specified total test period shall be extended by the interruption time for corrective work.

4. Test Records

Contractor shall continuously record all function and operation parameters during the entire test period. Contractor shall submit complete, well organized, and clearly labeled test data to the District for review and approval.

END OF SECTION 16010

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