

SECTION 16050

BASIC ELECTRICAL MATERIALS & METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. General

1. All labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services shall be provided as required to make a complete working electrical installation, as shown on the drawings and described in the specifications.
2. This section encompasses products, assemblies and basic installation methods required for electrical project systems specified under this division and includes, but is not limited to:
 - a. Conduit, raceways, and fittings
 - b. Wire and cables
 - c. Wire connections and devices
 - d. Outlet boxes
 - e. Pull and junction boxes
 - f. Switches and receptacles
 - g. Device plates
 - h. Over current protective devices
 - i. Supporting devices
 - j. Floor boxes
 - k. Motor Control Centers
 - l. Panelboards
 - m. Low voltage dry type transformers

- n. 110 Volt Power on E-Power is Required to all UPS serving BMS Panels. Min. of 1 BMS Panel is required per Floor at preferred location TeleData Closet / central location on each floor.

1.2 SUBMITTALS:

A. General

1. Submittal data shall be bound in an 8-1/2 inch by 11 inch folder or binder with a table of contents listing items in order of specification section and paragraph number.
2. Submittals shall consist of detailed shop drawings, specifications, catalog “cuts” and data sheets containing physical and dimensioned information, performance data, electrical characteristics, materials used in fabrication, material finish and those which are excluded. In addition, seismic data regarding installation and seismic withstand certification shall be included where applicable.
3. The Contractor agrees that shop drawing submittals are not change orders; that the purpose of shop drawing submittals by the contractor is to demonstrate that the contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use.

B. Specific Requirements: The following items shall be submitted in accordance with Paragraphs 1.02.A.1 through 4 (above):

1. Switches, Receptacles, and Lighting Control Systems: Submittal data shall clearly indicate UL and NEMA compliance.
2. Device plates, including engraving schedules where engraved plates are specified.
3. Floor boxes and pedestal boxes
4. Motor Control Centers
5. Panelboards
6. Dry type transformers
7. Variable frequency drives.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Materials: Materials shall be new and shall be delivered to the job site in the original packaging.

1.4 SERVICE DISCONNECTION AND INTERRUPTION

- A. Service Disconnection: All circuits and controls to be disconnected shall be traced as directed by the Project Manager to ensure that vital services to other areas are not interrupted.
- B. Service Interruption: All service interruptions shall be scheduled through SHC Engineering and Maintenance by providing notice five (5) working days in advance.

PART 2 - PRODUCTS

2.1 CONDUIT

A. General:

1. Each length of conduit shall bear the UL label.
2. Minimum acceptable conduit size shall be ½ inch. Conduit fill for branch circuits (not feeders) shall be limited to the maximum for the next smaller size conduit to allow for future additions. Exceptions: Short runs to a single outlet in existing work (remodel) may be ½ inch. Extensions and connections to single fixtures may be ½ inch.

2.2 WIRE AND CABLE

A. General

1. All cable installations shall be performed to manufacturer's recommendations except as noted below.
2. All wire and cable shall be new and bear the UL label.
3. All wire shall be stranded copper. Exception: wire used in fire alarm circuits shall be solid copper per NEC 760-16.
4. All wire and cable for secondary power distribution shall be 600 volt insulated, THHN/XHHW or THHN/THWN. Wire installed in conduits in wet or underground locations shall be type THWN/XHHW or THHN/THWN.
5. Minimum conductor sizes:

- a. Power and lighting branch circuits: #12 wire gage (AWG)
- b. Signal and control circuits over 100 volts: #14 AWG
- c. Fire alarm: Refer to Section 16721 Fire Alarm Systems.
- d. Low voltage (50 volts or less): #14 AWG or specified cables

2.3 WIRE DEVICES

A. General

- 1. All power receptacles and switches for general purpose circuits shall be NEMA specification grade, rated as follows:
 - a. General purpose receptacles: NEMA 5-15R or 5-20R
 - b. Lab bench receptacles: NEMA 5-20R
 - c. Dedicated receptacles: NEMA 5-20R
 - d. Switches: Twenty (20) ampere. Note: in mechanical equipment rooms illuminated light switches shall be provided.
- 2. All general purpose twenty (20) amp, 125/250 volt receptacles and 120/227 volt switches shall conform to NEMA WD-1 specifications.
- 3. Outlets served from an emergency power system shall be red. Outlets served from the normal power system shall be ivory or white.

2.4 BOXES AND FITTINGS

- A. Standard Outlet Boxes: Galvanized, one-piece, drawn steel, knock-out type of size and configuration best suited to the application indicated on the plans. Minimum box size: four (4) inches square by 1-1/2 inches deep.
- B. Switch Boxes: two (2) inches wide by three (3) inches long, galvanized steel switch boxes shall be used only for the installation of single switches. Multiple switches shall be installed in standard gang boxes with raised device covers suitable for the application indicated.

2.5 WIRE CONNECTORS

- A. Wire Joints: Wires in sizes from #18 to #8 AWG conductor, with insulation rated 105° C or less shall be joined with electrical spring connectors of three-part construction

incorporating a non-restricted, zinc-coated steel spring enclosed in a steel shell with an outer jacket of vinyl plastic with a flexible insulating skirt. Wire sizes #6 AWG and larger shall be joined with solid copper split-bolt connectors torqued to proper value and taped, or with properly insulated copper compression connectors installed according to the manufacturer's instructions.

- B. Splicing and Insulating Tape (600 volt and below): General purpose electrical tape shall be suitable for temperatures from minus 18° C to 105° C and shall be black, ultraviolet-proof, self-extinguishing, seven (7) mil thick vinyl.

2.6 DISTRIBUTION PANEL BOARDS

A. General

1. Distribution panels shall be three (3) phase, except in those few cases where building power is single phase.
2. Each new panel shall be installed leaving not less than twenty-five (25) percent of the breaker positions spare, with associated copper bus and hardware provided for future breaker installation. Bus shall extend full length of panelboard.
3. Each circuit shall be identified on a panel directory. The configuration of the panel directory shall be the same as the panel itself. Feeder breakers shall be separately labeled with engraved, laminated nameplates.
4. Feeder breakers and breakers feeding individual pieces of equipment shall be separately labeled with engraved, laminated nameplates.
5. Panel numbers shall be shown inside the panel door.
6. Lighting and receptacle distribution panels shall be located in corridors or electrical closets. Panels shall not be located in janitorial closets. Panels in laboratory rooms shall be in accessible locations and shall not be located over lab benches or behind movable or fixed equipment.
7. Branch circuit breakers shall be bolt-on type.
8. Cabinets shall be provided with stretcher-leveled steel doors and trim of code thickness, complete with concealed butt hinges, one door over interior and one which exposes all wiring. Flush, combination spring catch and lock shall be provided on each door with good fitting joints between doors and trim. Locks on all panelboards, cabinets, and switchboards shall be keyed alike. Doors thirty-six (36) inches and over shall be secured with slotted-head, one quarter turn captive speed fasteners, located at the top and bottom of the door in addition to the lock. Clamp-type holders will not be accepted.

9. All panelboards shall be constructed with copper bus and adequate ground bars shall be provided.

B. Acceptable Manufacturers:

1. General Electric
2. Square D
3. Siemens
4. Cutler-Hammer

2.7 PROTECTIVE DEVICES

- A. Circuit Breakers: Branch circuit breakers shall be molded case, bolt-on, thermal magnetic type, ambient temperature compensated. Main and feeder breakers shall be molded case or insulated case type.
- B. Fuses and Fused Switches: Fused distribution switchboards shall be used where high short circuit currents prevent the economical use of circuit breakers or as specifically approved. Fuses shall be current-limiting, time-delay type and fuse clips shall be provided with rejection features to prevent the use of improper fuses. A full compliment of spare fuses shall be provided.

2.8 DISCONNECT SWITCHES

- A. Enclosures: NEMA 1, code gauge sheet steel with hinged cover, or as shown on the drawings for interior locations. Switches in exterior locations shall be provided with NEMA 3R enclosures.

2.9 MOTOR AND CONTROLLERS

- A. General: Energy-efficient motors shall be selected on the basis of Life Cycle Cost Analysis.
 1. Full voltage starters: Across-the-line, magnetic type, double-break silver alloy contacts, molded operating coil, and ambient compensating thermal overload relays on all phase conductors.
 2. Manual Motor Starters: Fractional horsepower (HP), single phase motors shall be protected by thermal overload relay integral with the disconnect.
 3. Motor protection shall be by thermal overload relays in each phase, and by motor circuit protector (MCP) in a combination starter or motor control center. MCP's shall be rated or set to properly protect the motor.

4. Reduced voltage starters (Autotransformer or Solid State) shall be provided on 208 volt motors larger than 30 HP and on 480 volt motors larger than 75 HP, or as required by the application. Solid state starters shall be as specifically approved.

B. Motor Control Centers

1. The MCC shall consist of the indicated number of vertical sections to accommodate circuit breakers, motor starters and other devices as specified. The structure shall be free standing and metal enclosed. It shall be completely inter-wired in accordance with NEMA Class 1, Type B, standards with terminals located in the individual control compartments.
2. Modules located in MCC shall be plug-in type to allow safe replacement without interruption power to the MCC.
3. Motor control centers shall be provided with twenty-five (25) percent extra space for future application or the installation shall be arranged for future addition of complete sections.

C. Variable Frequency Drives: All variable frequency drive installations shall be equipped with line bypass to allow constant-speed motor operation during maintenance shutdown of variable frequency drive unit.

2.10 LOW VOLTAGE DRY-TYPE TRANSFORMER

A. General:

1. Self-cooled by natural convection indoor, dry type UL listed. Autotransformers and not acceptable.
2. 480 volt delta primary, 120/208 volt, 3-phase, four (4) wire. KVA size shall be shown on the drawings.
3. Ratings shall be indicated on the drawings and shall be for continuous duty without use of cooling fans.
4. Temperature rise shall not exceed 150° C with limiting temperature in accordance with NEMA standards.
5. Core and coil assemblies:
 - a. Rigidly brace to withstand the stresses caused by short circuit currents and rough handling during shipping.

- b. Cores shall be grain oriented, non-aging, silicon steel
 - c. Coils shall be continuous windings without splices except for taps.
 - d. Coil loss and core loss shall be optimum for efficient operation
 - e. Coil windings shall have end filters or tie downs for maximum strength.
6. All transformers rated 30 KVA and larger shall have two (2) 2.5 percent full capacity taps above and two (2) 2.5 percent full capacity taps below normal rated primary voltage.
7. Core assemblies shall be grounded to their enclosures by adequate, flexible, ground straps.
8. Enclosures:
- a. Enclosures shall be not less than code gauge steel.
 - b. Temperature rise at hottest spot shall conform to NEMA standards
 - c. Ventilation openings shall prevent accidental access to live components.
 - d. Metal shall be thoroughly cleaned and painted at the factory with primer and the manufacturer's standard finish.
9. Standard NEMA features and accessories, including ground pad, lifting provisions, and nameplate with the wiring diagram and sound level indicated on it shall be provided.

2.11 ELECTRICAL SUPPORTING DEVICES

- A. Concrete Fasteners: Powder-driven concrete pin fasteners, low velocity type.
- B. Conduit Straps: Hot-dip galvanized, steel one-hold type strap with cast clam-backs and spacers as required.
- C. Construction Channel: 1-1/2 inch by 1-1/2 inch, twelve (12) gauge galvanized steel channel with 17/32 inch diameter bolt holes, 1-1/2 inches on center.
- D. Fasteners (General): Wood screws for fastening to wood. Machine screws for fastening to steel. Toggle bolts or "molly" for fastening to hollow concrete block, gypsum board, or plaster walls. Expansion anchors for attachments to pre-poured concrete.

2.12 IDENTIFYING DEVICES

- A. Nameplates: Nameplates shall be engraved laminated, 1 inch x 3-1/2 inch machine screw retained, for permanent identification of all panelboards, transformers, switchboards, motor starters, and cabinet enclosed apparatus. Color shall be black with white letters for 208/120 volt equipment and yellow with black letters for 480/277 volt enclosures. Panelboard numbers shall be inside the panel door.
- B. Panelboard Directories: Panelboard Directories shall be typewritten, arranged in numerical order, and shall show the number of the room in which each outlet served by each panelboard circuit is located. The room numbers used shall be verified and shall not necessarily be those used on the drawings. Directories shall be mounted in a six (6) inch by eight (8) inch metal frame under glass or transparent plastic inside each panelboard door.
- C. Wire and Terminal Markers: Wire and terminal markers shall be self adhering, pre-printed cloth or vinyl.

PART 3 – EXECUTION

3.1 CONDUIT AND RACEWAY INSTALLATION

- A. General:
 - 1. Wherever possible, conduits shall be concealed in walls or furred ceilings and in poured-in place concrete slabs. Concealed conduits shall be run in as direct a route as possible and with bends of large radii. Floor penetrations shall be made only at specific approved locations; other penetrations are prohibited. In furred ceiling areas, conduits shall be run above carrying bars. Conduits shall be rigidly secured in position by means of approved clamps.
 - 2. Location of conduit runs shall be planned in advance of the installation and coordinated with the ductwork, plumbing, ceiling, and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor prevent removal of ceiling tiles or panels, nor block access to mechanical or electrical equipment.
 - 3. All exposed conduits shall be installed straight and true with reference to the adjacent work.
 - 4. Exposed vertical conduit runs shall be supported at each floor level, independent of cabinets or switches to which they run, by means of approved supports.

5. For rigid steel conduit, running threads and threadless couplings will not be acceptable. Where necessary for connecting conduit UL listed couplings or unions shall be used.

B. Supports:

1. All raceway systems shall be secured to building structures using specified fasteners, clamps, and hangers spaced according to code requirements.
2. Single runs of conduit shall be supported using one hole pipe straps. Where run horizontally on walls in damp or wet locations, "clamp backs" shall be installed to space conduit off the surface.

3.2 WIRING AND CABLE INSTALLATION

A. General

1. Conductors shall not be installed in conduit until all work of any nature that may cause injury is completed. Care shall be taken in pulling conductors such that insulation is not damaged. UL approved pulling compounds shall be used as needed.
2. All cables shall be installed and tested in accordance with manufacturer's requirements and warranty.

B. Grounding: Enclosures of equipment, raceways and fixtures shall be permanently and effectively grounded. A code-sized, copper, insulated green equipment ground shall be provided for all branch circuit and feeder runs. Equipment ground shall originate at panelboard ground bus and shall be bonded to all switch and receptacle boxes and electrical equipment enclosures. Ground terminals on receptacles shall be connected to the equipment grounding conductor by an insulated copper conductor.

C. Signal Wiring: Wire used for alarm and control signal applications shall be identified at both ends and referenced to appropriate as-built drawings.

1. Fire alarm wiring shall be color coded in accordance with Section 16721: Fire Alarm Systems.
2. Security alarm wiring shall be installed in accordance with NEC, it shall be Class A, or B, and where it is vulnerable to physical abuse, shall be in metallic conduit.
3. Control wiring shall be numerically or otherwise coded in accordance with as-built control diagrams. See Section 15900: Central Controls and Instrumentation.

3.3 INSTALLATION OF BOXES AND WIRING DEVICES.

A. General:

1. All outlets shall finish flush with building walls, ceilings, and floors, except where exposed work is required.
2. Raised device covers (plaster rings) shall be installed on all outlet boxes concealed in concrete, masonry, or stud walls, or in furred, suspended, or exposed concrete ceilings. Covers shall be of a depth to suit the wall or ceiling flush.

B. Box Layout:

1. Outlet boxes shall be installed at the locations and elevations shown on the drawings or specified herein. Adjustments to locations shall be made as required by structural conditions and to suit coordination requirements of other trades.

C. Supports.

1. Boxes installed in metal stud walls shall be equipped with brackets designed for attaching directly to the studs, or shall be mounted on heavy gauge galvanized steel, snap-in box supports.
2. Fixture outlet boxes installed in suspended ceilings of gypsum board or lath and plaster construction shall be mounted to sixteen (16) gauge metal channel bars attached to main ceiling runners.
3. Fixture outlet boxes installed in suspended ceilings supporting acoustical tiles or panels shall be supported directly from the structure above wherever pendent-mounted lighting fixtures are installed on the box.
4. Outlet boxes mounted suspended acoustical tile ceiling having concealed suspension systems may be supported from main ceiling runners. Boxes mounted above suspended ceiling having exposed suspension systems shall be supported directly from the structure above, independent of the ceiling suspension system.

3.4 MOTOR CONTROL CENTER, SWITCHBOARD AND PANELBOARD INSTALLATION

A. General

1. Free-standing switchboards, distribution panels, etc. shall be accurately aligned, leveled, and bolted in place on full-length channels securely fastened to the floor, and braced for seismic restraint in accordance with CAC Title 24.
2. Equipment cabinets, motor control centers, etc. shall be anchored and braced to withstand seismic forces, calculated in accordance with the UBC, Section 2314. Transformers suspended on hangers shall be provided with appropriate seismic restraint.
3. Interior wiring shall be bundled and clamped using specified plastic wire wraps.
4. Nameplates, legend plates, and panel directories as specified in Article 2.12 (above) shall be installed.

3.5 TRANSFORMER INSTALLATION

A. General:

1. Primary shall be connected to minimum value taps during construction period and prior to initial building start-up.
2. Voltage readings shall be made and tap connections adjusted to nominal voltage during final construction review and prior to building occupancy.
3. Transformers shall be installed on vibration pads designed to suppress the transformer vibrations. Pads shall be selected and arranged in accordance with the weights of the transformers.
4. Conduit connections that will prevent transmission of the transformer vibrations to the conduit system shall be installed.
5. Transformers installed against a wall shall have readily accessible primary and secondary terminals.

3.6 PROTECTION

A. General

1. Conduits, junction boxes, outlet boxes, and other openings shall be kept closed to prevent entry of foreign matter. Fixtures, equipment, and apparatus shall be

covered and protected against dirt, paint, water, chemical or mechanical damage, before and during the construction period. Damaged fixtures, apparatus, or equipment shall be restored to original condition prior to final acceptance, including restoration of damaged shop coats of paint. Brightly finished surfaces and similar items shall be protected until in service. No rust or damage will be permitted.

3.7 WORKMANSHIP

A. General

1. Preparation, handling, and installation shall be in accordance with manufacturer's written instructions and technical data particular to the product specified and/or approved, except as otherwise specified.
2. Work shall be furnished and placed in coordination and cooperation with other trades.
3. Work shall conform to the National Electrical Contractor's Association Standard of Installation for general installation practice.

3.8 ELECTRICAL TESTING

A. General

1. All materials, supplies, tools, equipment, labor, and services shall be provided to perform all tests as specified in this section.
2. Test reports shall be submitted to the Project Engineer and the Project Manager
3. All deficiencies revealed by tests shall be corrected. All material and equipment found faulty by tests shall be replaced.
4. Contractor shall furnish the services of an independent electrical testing firm acceptable to the Project Manager to conduct all testing.
5. A written record of all tests shall be maintained showing date, personnel making test, equipment or material tested, tests performed, manufacturer and serial number of testing equipment and results.
6. Contractor shall be responsible for any damage to equipment or material due to improper test procedures or test apparatus handling, and shall replace or restore to original condition any damaged equipment or material.

B. Work Included.

1. All wire, cable, equipment, and systems installed or connected under electrical contract shall be tested to assure proper installation, setting, connection, and functioning in accordance with the drawings, specifications, and the manufacturer's recommendations. The intent herein is that field testing be extensive and complete as specified, to provide assurance of correct installation and operation of equipment.
2. All tests and inspections recommended by the equipment manufacturer shall be included, whether required by these specifications or not, unless specifically waived by the Project Engineer.
3. Tests shall included but are not limited to the following:
 - a. All wiring: Free of shorts unintentional and grounds.
 - b. Molded case breakers 150 amp and larger. Time and instantaneous tripping, physical condition, contact resistance, insulation resistance.
 - c. Power circuit breakers: Calibration to time/current curves, physical condition, contact resistance, insulation resistance.
 - d. Grounding system: Ground resistance (impedance), ground integrity.
 - e. High voltage cable: As specified in Stanford Campus Guidelines, Underground Power Distribution.
 - f. Motor Controls: Proper overload sensing, insulation resistance.
 - g. Ground fault system: Neutral free of improper grounds, pick-up, coordination, zone interlocking.
 - h. Protective relays: Pick-up, timing, insulation resistance, physical condition.
 - i. Switchboards, panelboards, bus duct, etc.: Insulation resistance, physical condition, proper torque on connections.

END OF SECTION