

## SECTION 16142 ELECTRICAL CONNECTIONS FOR EQUIPMENT

## PART 1 GENERAL

## 1.1 SUMMARY:

- A. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.
- B. Applications of electrical power connections specified in this section include the following:
  - 1. To resistive heaters.
  - 2. From electrical source to motor starters.
  - 3. From motor starters to motors.
  - 4. To lighting equipment.
  - 5. To converters, rectifiers, transformers, inverters, rheostats, and similar current adjustment features of equipment.
  - 6. To grounds including earthing connections.
  - 7. To master units of communication, signal, alarm, clock, public address, sound, and video systems.
  - 8. Other connections as shown.

## 1.2 QUALITY ASSURANCE:

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors and terminals, of types and ratings required, and ancillary connection materials, including electrical insulating tape, soldering fluxes, and cable ties, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firms with at least 2 years of successful installation experience with projects utilizing electrical connections for equipment similar to that required for this project.

## 1.3 SUBMITTALS:

- A. Product Data: Submit manufacturer's data on electrical connections for equipment products and materials.

## 1.4 DEFINITIONS:

- A. Load voltage wiring shall be defined as:

Conduit and wiring required to carry power to motors and other equipment or devices. Wiring from control devices to equipment that carry power to drive that equipment such as line voltage thermostats, etc., shall be included as load voltage wiring. Wiring that provides power to control panels, control transformers, control relays, time clocks, etc., shall also be included as load voltage wiring.

## 1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver electrical connection products wrapped in proper factory fabricated type containers.
- B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.

- C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS:

- A. Manufacturer: Subject to compliance with requirements, provide circuit and motor disconnects by one of the following:
  - 1. Square D Company
  - 2. Cutler-Hammer Inc.
  - 3. General Electric Co.
  - 4. Siemens Energy & Automation, Inc.
  - 5. Westinghouse Electric Corp.

### 2.2 GENERAL:

- A. Overcurrent Protective Devices (OCPDs): Provide type, rating, and features as indicated. Comply with Division 16 Section on Overcurrent Protective Devices, with OCPDs adapted to equipment connection installation. Tandem circuit breakers shall not be used. Multiple breakers shall have common trip.
- B. Provide motor controllers that are horsepower rated to suit the motor controlled.
- C. Contacts shall open each ungrounded connection to the motor. Contacts shall be NEMA rated, 75°C.
- D. Overload relays shall be ambient-compensated type with inverse-time-current characteristic. Provide with heaters or sensors in each phase matched to nameplate full load current of the specific motor to which connected with appropriate adjustment for duty cycle and power factor correction supplied with the motor.

### 2.3 MATERIALS AND COMPONENTS:

- A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, disconnect, starter, contactor, relays, etc., and other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings:
  - 1. General: Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Provide products complying with Division-16 section on Raceways.
- C. Wires, Cables, and Connectors:
  - 1. General: Provide wires, cables, and connectors complying with Division-16 section on Wires and Cables.
  - 2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes, ratings, and material of wires/cables which are supplying electrical power.

3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.
5. Cord and Plug Connected Equipment: Where indicated, contractors shall provide a length of SO cord complete with a straight blade or twist-lock receptacle for connection of equipment. Cord and plug rating shall be suitable for the connected equipment load and rating of the branch circuit overcurrent protective device. Plug shall match receptacle configuration included on the plans and cord length shall be as required. Contractor shall connect cord to equipment.

#### 2.4 MANUAL MOTOR STARTERS:

- A. Manual starters shall be flush-mounting type except where conduits are run exposed or as otherwise noted. Manual starters shall be complete with properly sized overload protection and neon pilot light. Manual starters shall be Square D Class 2510 or Allen-Bradley Bulletin 600 with stainless steel plates.
- B. Motor starter shall have a spare set of auxiliary N.O. and N.C. contacts supplied with starter.
- C. Heater units in all manual motor starters shall be sized for approximately 115 percent of full load motor current. Check and coordinate all thermal protective devices with the equipment they protect.

#### 2.5 CIRCUIT AND MOTOR DISCONNECT SWITCHES:

- A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated. All equipment with maximum fuse size listed in nameplate shall have fusible disconnect switch provided. Provide NEMA 1 enclosure. For outdoor switches and switches indicated as weatherproof, provide NEMA 3R enclosures with raintight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.
- B. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses. All disconnect switches shall be fusible unless otherwise noted. Provide UL type "HD" 100 percent duty rated switches.
- C. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated. Provide UL type "HD" 100 percent duty rated switches.
- D. Double-Throw Switches: Heavy duty switches of classes and current ratings as indicated.
- E. Switches for Classified (Hazardous) Locations: Heavy duty switches, with UL labels and listings for hazardous location classifications in which installed.
- F. Accessories:
  1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated or required.

2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated:
  - a. Stainless Steel Type 304: For NEMA Type 4.
  - b. Molded Fiberglass Reinforced Plastic: For NEMA Type 4x.
  - c. Heavy Cast Aluminum: For hazardous locations. NEMA Types 7 through 9.
3. Handles shall be lockable in open and closed position without modification.

## 2.6 AUXILIARY CONTROL DEVICES:

- A. General: Provide the following factory installed in controller enclosure except as otherwise indicated. Where separately mounted, provide NEMA 1 enclosure except as otherwise indicated.
  1. Pushbutton Stations, Pilot Lights, and Selector Switches: Heavy-duty type. HAND-OFF-AUTOMATIC (H-O-A) switches shall be provided on all magnetic starters. Provide magnetic two-speed starters with a HIGH-LOW selector with H-O-A switch wired to allow manual speed selection in HAND position and remote speed selection in AUTO.
  2. Stop and Lockout Pushbutton Station: Momentary-break pushbutton station with a factory-applied hasp arranged so a padlock can be used to lock the pushbutton in the depressed position with the control circuit open.
  3. Control Relays: Auxiliary and adjustable time-delay relays as required to coordinate with Division 15 Controls Section.
  4. Elapsed Time Meters: Heavy duty with digital readout in hours. Provide on all magnetic starters for motors.
  5. Ammeters, Voltmeters, and Frequency Meters: Panel type, 2-1/2 inch minimum size with 90 degree or 120 degree scale and plus or minus 2 percent accuracy. Where indicated, provide transfer device with an off position.
  6. Current Sensors: Rated to suit application.
  7. Phase-Failure Relay: Provide relay for each motor 2 HP and larger. Relay shall have solid-state sensing circuit with isolated contacts for hard-wired connection to socket. Provide matching pin type relay and hold down clamps. Relay shall be arranged to operate on phase failure, phase reversal, current unbalance of from 30 to 40 percent, or loss of supply voltage. Provide adjustable response delay, and adjustable under-voltage setting.

## PART 3 - EXECUTION

### 3.1 INSPECTION:

- A. Inspect area and conditions under which electrical connections for equipment are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

### 3.2 INSTALLATION OF ELECTRICAL CONNECTIONS:

- A. Furnish, set in place, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, plumbing and fire protection, elevator, etc., motors and controls in accordance with the following schedule and in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements. Carefully coordinate with work performed under the Mechanical Division of these Specifications.

- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
  - C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
  - D. Maintain existing electrical service and feeders to equipment serving occupied areas and operational facilities, unless otherwise indicated, or when authorized otherwise in writing by Owner, or Architect/Engineer. Provide temporary service during interruptions to existing facilities. When necessary, schedule momentary outages for replacing existing wiring systems with new wiring systems. When the "cutting over" has been successfully accomplished, remove, relocate, or abandon existing wiring as indicated.
  - E. Cover splices with electrical insulating material equivalent to, or of greater insulation resistive rating, than electrical insulation rating of those conductors being spliced.
  - F. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.
  - G. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
  - H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque values for equipment connectors. Accomplish tightening by utilizing proper tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL's 486A.
  - I. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
  - J. Provide suitable strain relief clamps for cord connection to outlet boxes and equipment connection boxes.
  - K. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
  - L. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated or per manufacturer's instructions.
  - M. Provide each motor with a horsepower rated disconnect switch and external thermal overload protection.
  - N. Provide circuit and motor disconnect switches as indicated and where required by Code. Comply with switch manufacturers printed installation instructions. Install within sight of motors.
- 3.3 FIELD QUALITY CONTROL:

- A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

3.4 EQUIPMENT CONNECTION SCHEDULES:

- A. Mechanical Equipment:
  - 1. Refer to Mechanical Equipment Schedule on the drawings.
  - 2. All load voltage wiring shall be provided under Division 16.
  - 3. Unless otherwise indicated, it is suggested that all equipment motors and control shall be furnished, set in place, and wired in accordance with the schedule contained herein. The exact furnishing and installation of the equipment is left to the Contractors involved. Contractor should note that the intent of this schedule is to have the Contractor responsible for coordinating all wiring as outlined, whether or not specifically called for by the Division 15 or Division 16 drawings and specifications. Comply with the applicable requirements of Division 16 for all electrical work which is not otherwise specified. No extras will be allowed for contractor's failure to provide for these required items. Contractor shall refer to the Division 16 and Division 15 specifications and plans for all power and control wiring and shall advise the Architect/Engineer of any discrepancies prior to bidding.

ITEM	FURNISHED BY	SET BY	CONTROL WIRING (non-load voltage)
1. Mechanical Equipment Motors	M	M	--
2. Special Equipment (i.e., elevators, etc.)			
a. Motors	G	G	--
b. Magnetic Motor Starters	G	E*	--
c. Disconnect Switches Thermal OL Switches Manual Operating Switches	E	E	--
3. Motor Starters, combination motor starter/disconnect and Variable Frequency Drives			
a. Automatically controlled, with or without HOA switches.	M	E*	M
b. Manually controlled.			
c. Starters integral with motor control centers including control relays and transformers.	M E	E* E	-- --
d. Combination Starter/Disconnects	M	E*	M
4. Pushbutton stations, pilot lights	M	E*	M
5. Disconnect switches, thermal overload switches, manual operating switches.	E	E*	M
6. Multi-speed switches	M	E*	M
7. Control relays, transformers.	M	M	M

8. Load voltage control items such as line voltage thermostats not connected to control panel systems.	M	M	E
9. Non-load voltage control items.	M	M	M
10. Electric thermostats, remote bulb thermostats, motor valves, float controls, etc., which are an integral part of mechanical equipment or directly attached to ducts, pipes, etc.	M	M	M
11. Motor valves, damper motor, solenoid valves, EP and PE switches, VAV box controls, actuators, etc.	M	M	M**
12. Control circuit outlets	E	E	--
13. Fire protection controls (Including flow switches)	M	M	M**
14. Duct smoke detectors, including relays for fan shutdown.	E	M	M**
15. Temperature Control Panel	M	M	M
16. Interlocks	M	M	M

G = General, Division 13 or 14

M = Mechanical, Division 15

E = Electrical, Division 16

\* For factory pre-wired equipment specified under other Divisions, all wiring within the equipment shall be by the manufacturer. Connection to the equipment shall be by Division 16, as shown on electrical drawings.

Manufacturer's equipment provided under other divisions which varies from what is shown on Division 16 drawings shall be the responsibility of the Contractor to complete and pay for any costs for those variations.

\*\* Fire alarm system control modules and wiring from fire alarm contacts to fire alarm system under Division 16. See details.

\*\*\* Integral control wiring under Electrical Division as manufacturer supplied equipment. Control wiring for automatic control portion under Mechanical Division.

4. Owner Furnished Equipment:

- a. Refer to Owner Equipment Schedule on drawings.
- b. Refer to System Coordination Schedule on drawings.

5. Kitchen Equipment:

- a. Refer to equipment plan, elevation drawings, and equipment Schedules.

END OF SECTION 16142