

## **SECTION 262913 - ENCLOSED CONTROLLERS**

Latest Update 5-6-2017 See underlined text for Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

### **PART 1 - GENERAL**

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

#### 1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
  - 1. Full-voltage manual.
  - 2. Full-voltage magnetic.
  - 3. Reduced-voltage magnetic.
  - 4. Reduced-voltage solid state.
  - 5. Multispeed.

#### 1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
  - 1. Show tabulations of the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Nameplate legends.
    - d. Short-circuit current rating of integrated unit.
    - e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.
    - f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
- D. Field quality-control reports.
- E. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for enclosed controllers and installed components.
  - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
  - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
- F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

## 1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; [install temporary electric heating, with at least 250 W per controller] [connect factory-installed space heaters to temporary electrical service]. <Engineer to Edit for Project Requirements>

## 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22°F and not exceeding 104°F.
  - 2. Altitude: Not exceeding six thousand six hundred (6,600) feet.
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than ten (10) days in advance of proposed interruption of electrical systems.
  - 2. Indicate method of providing temporary utilities.
  - 3. Do not proceed with interruption of electrical systems without Owner's written permission.
  - 4. Comply with NFPA 70E.

## 1.8 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

## 1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Control Power Fuses: Equal to [10] <Insert number> percent of quantity installed for each size and type, but no fewer than [two] <Insert number> of each size and type.
  - 2. Indicating Lights: [Two] <Insert number> of each type and color installed.
  - 3. Auxiliary Contacts: Furnish [one] <Insert number> spare(s) for each size and type of magnetic controller installed.
  - 4. Power Contacts: Furnish [three] <Insert number> spares for each size and type of magnetic contactor installed.
  - 5. <Insert extra materials>.

## 1.10 WARRANTY/GUARANTEE

- A. See Division 26 Specification Section “Basic Electrical Requirements” for warranty and guarantee requirements.

## **PART 2 - PRODUCTS**

### 2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - c. Rockwell Automation, Inc.; Allen-Bradley brand.
  - d. Siemens Energy & Automation, Inc.
  - e. Square D; a brand of Schneider Electric.
  - f. <Insert manufacturer's name>.
2. Configuration: [Non-reversing] [Reversing] [Two speed]. <Engineer to Edit for Project Requirements>
  3. [Flush] [Surface] mounting. <Engineer to Edit for Project Requirements>
  4. [Red] [Green] pilot light. <Engineer to Edit for Project Requirements>
  5. Additional Nameplates: [FORWARD and REVERSE for reversing switches] [HIGH and LOW for two-speed switches] <Insert special markings>.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - c. Rockwell Automation, Inc.; Allen-Bradley brand.
    - d. Siemens Energy & Automation, Inc.
    - e. Square D; a brand of Schneider Electric.
    - f. <Insert manufacturer's name>.
  2. Configuration: [Non-reversing] [Two speed]. <Engineer to Edit for Project Requirements>
  3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, [Class 10] <Insert class> tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button[; bimetallic type] [; melting alloy type].
  4. [Flush] [Surface] mounting. <Engineer to Edit for Project Requirements>
  5. [Red] [Green] pilot light. <Engineer to Edit for Project Requirements>
  6. Additional Nameplates: [HIGH and LOW for two-speed controllers] <Insert special markings>.
- D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - c. Rockwell Automation, Inc.; Allen-Bradley brand.
  - d. Siemens Energy & Automation, Inc.
  - e. Square D; a brand of Schneider Electric.
  - f. <Insert manufacturer's name>.
2. Configuration: [Non-reversing] [Reversing] [Two speed].<Engineer to Edit for Project Requirements>
  3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, [Class 10] <Insert class> tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of actual protected motor and having appropriate adjustment for duty cycle; external reset push button[; bimetallic type] [; melting alloy type].<Engineer to Edit for Project Requirements>
  4. [Flush] [Surface] mounting. <Engineer to Edit for Project Requirements>
  5. [Red] [Green] pilot light. <Engineer to Edit for Project Requirements>
  6. Additional Nameplates: [FORWARD and REVERSE for reversing controllers] [HIGH and LOW for two-speed controllers] <Insert special markings>.
  7. [N.O.] [N.C.] auxiliary contact.<Engineer to Edit for Project Requirements>
- E. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - c. Rockwell Automation, Inc.; Allen-Bradley brand.
    - d. Siemens Energy & Automation, Inc.
    - e. Square D; a brand of Schneider Electric.
    - f. <Insert manufacturer's name>.
  2. Configuration: [Non-reversing] [Reversing].<Engineer to Edit for Project Requirements>
  3. Contactor Coils: Pressure-encapsulated type [with coil transient suppressors].<Engineer to Edit for Project Requirements>
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: [24] [120] V ac; obtained from integral CPT, with primary and secondary fuses of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices. The CPT shall be a constant-voltage control power transformer. <Engineer to Edit for Project Requirements>
    - a. CPT Spare Capacity: 100 VA.
    - b. Inverse-time-current characteristic.
    - c. [Class 10] [Class 20] [Class 30] tripping characteristic. <Engineer to Edit for Project Requirements>
    - d. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  6. Bimetallic Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. [Class 10] [Class 20] [Class 30] tripping characteristic. <Engineer to Edit for Project Requirements>
    - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - d. Ambient compensated.
    - e. Automatic resetting.
  7. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor running overload protection.
    - b. Sensors in each phase.
    - c. [Class 10] [Class 20] [Class 10/20 selectable] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing. <Engineer to Edit for Project Requirements>
    - d.
  8. [N.C.] [N.O.], isolated overload alarm contact. <Engineer to Edit for Project Requirements>
  9. External overload reset push button.
- F. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - c. Rockwell Automation, Inc.; Allen-Bradley brand.

- d. Siemens Energy & Automation, Inc.
  - e. Square D; a brand of Schneider Electric.
  - f. <Insert manufacturer's name>.
2. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  3. Nonfusible Disconnecting Means:
    - a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
  4. MCP Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - d. [N.C.] [N.O.] alarm contact that operates only when MCP has tripped.  
<Engineer to Edit for Project Requirements>
  5. MCCB Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - e. [N.C.] [N.O.] alarm contact that operates only when MCCB has tripped.<Engineer to Edit for Project Requirements>

## 2.2 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

- A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.



B. Reduced-Voltage Magnetic Controllers: Reduced voltage, electrically held.

1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
  - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - c. Rockwell Automation, Inc.; Allen-Bradley brand.
  - d. Siemens Energy & Automation, Inc.
  - e. Square D; a brand of Schneider Electric.
  - f. <Insert manufacturer's name>.
2. Configuration:
  - a. Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.
  - b. Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
  - c. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50%, 65%, and 80 % of line voltage; two START and one RUN contactors.
3. Contactor Coils: Pressure-encapsulated type [with coil transient suppressors]. <Engineer to Edit for Project Requirements>
  - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
5. Control Circuits: [24] [120] V ac; obtained from integral CPT, with primary and secondary fuses of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices. The CPT shall be a constant-voltage control power transformer. <Engineer to Edit for Project Requirements>
  - a. CPT Spare Capacity: 100 VA.
6. Melting Alloy Overload Relays:
  - a. Inverse-time-current characteristic.
  - b. [Class 10] [Class 20] [Class 30] tripping characteristic. <Engineer to Edit for Project Requirements>

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- c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
7. Bimetallic Overload Relays:
    - a. Inverse-time-current characteristic.
    - b. [Class 10] [Class 20] [Class 30] tripping characteristic. <Engineer to Edit for Project Requirements>
    - c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
    - d. Ambient compensated.
    - e. Automatic resetting.
  8. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor running overload protection.
    - b. Sensors in each phase.
    - c. [Class 10] [Class 20] [Class 10/20 selectable] <Insert class> tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
    - d. Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting. <Engineer to Edit for Project Requirements>
    - e. Analog communication module.
  9. [N.C.] [N.O.], isolated overload alarm contact. <Engineer to Edit for Project Requirements>
  10. External overload reset push button.
- C. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
  2.
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - c. Rockwell Automation, Inc.; Allen-Bradley brand.
    - d. Siemens Energy & Automation, Inc.
    - e. Square D; a brand of Schneider Electric.
    - f. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
    - g. <Insert manufacturer's name>.
  3. Nonfusible Disconnecting Means:

- a. NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
  - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - c. Auxiliary Contacts: N.O./N.C., arranged to activate before switch blades open.
4. MCP Disconnecting Means:
- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
  - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
  - d. [N.C.] [N.O.] alarm contact that operates only when MCP has tripped.
  - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA. <Engineer to Edit for Project Requirements>
5. MCCB Disconnecting Means:
- a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
  - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
  - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
  - e. [N.C.] [N.O.] alarm contact that operates only when MCCB has tripped. <Engineer to Edit for Project Requirements>

## 2.3 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS

- A. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.
- B. Reduced-Voltage Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
  1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

- a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - c. Rockwell Automation, Inc.; Allen-Bradley brand.
  - d. Siemens Energy & Automation, Inc.
  - e. Square D; a brand of Schneider Electric.
  - f. <Insert manufacturer's name>.
2. Configuration: [Standard duty] [Severe duty]; [nonreversible] [reversible].
  3. Starting Mode: [Voltage ramping] [Current limit] [Torque control] [Torque control with voltage boost][; field selectable]. <Engineer to Edit for Project Requirements>
  4. Stopping Mode: [Coast to stop] [Adjustable torque deceleration] [Adjustable braking] [; field selectable]. <Engineer to Edit for Project Requirements>
  5. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
  6. Shorting [and Input Isolation] Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. [Provide coil transient suppressors.] <Engineer to Edit for Project Requirements>
  7. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
  8. Control Circuits: [24][120] V ac; obtained from integral CPT, with primary and secondary fuses of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices. The CPT shall be a constant-voltage control power transformer. <Engineer to Edit for Project Requirements>
    - a. CPT Spare Capacity: 100 VA.
  9. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to [400] <Insert value> percent current limitation for 20 seconds.
  10. SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration [with] [without] external feedback from the motor or driven equipment.
  11. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions: <Engineer to Edit for Project Requirements>
    - a. Adjusting motor full-load amperes, as a percentage of the controller's rating.
    - b. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
    - c. Adjusting linear acceleration and deceleration ramps, in seconds.
    - d. Initial torque, as a percentage of the nominal motor torque.

- e. Adjusting torque limit, as a percentage of the nominal motor torque.
  - f. Adjusting maximum start time, in seconds.
  - g. Adjusting voltage boost, as a percentage of the nominal supply voltage.
  - h. Selecting stopping mode, and adjusting parameters.
  - i. Selecting motor thermal overload protection class between 5 and 30.
  - j. Activating and de-activating protection modes.
  - k. Selecting or activating communication modes.
  - l. <Insert function>.
12. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
- a. Controller Condition: Ready, starting, running, stopping.
  - b. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
  - c. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor underload, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
  - d. <Insert items>.
13. Controller Diagnostics and Protection:
- a. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
  - b. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and underload conditions; and line frequency over or under normal.
  - c. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.
  - d. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
  - e. <Insert items>.
14. Remote Output Features:
- a. All outputs prewired to terminal blocks.
  - b. Form C status contacts that change state when controller is running.
  - c. Form C alarm contacts that change state when a fault condition occurs.
  - d. <Insert items>.
15. Optional Features:
- a. Analog output for field-selectable assignment of motor operating characteristics; [0 to 10-V dc] [4 to 20-mA dc]. <Engineer to Edit for Project Requirements>

- b. Additional field-assignable Form C contacts, as indicated, for alarm outputs.
- c. Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 % or more above nominal line voltage.
- d. Full-voltage bypass contactor operating [automatically] [manually, with normal/bypass selector switch]. Power contacts shall be totally enclosed, double break, and silver-cadmium oxide; and assembled to allow inspection and replacement without disturbing line or load wiring. <Engineer to Edit for Project Requirements>
- e. Melting Alloy Overload Relays:
  - 1) Inverse-time-current characteristic.
  - 2) [Class 10] [Class 20] [Class 30] tripping characteristic. <Engineer to Edit for Project Requirements>
  - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
- f. Bimetallic Overload Relays:
  - 1) Inverse-time-current characteristic.
  - 2) [Class 10] [Class 20] [Class 30] tripping characteristic. <Engineer to Edit for Project Requirements>
  - 3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
  - 4) Ambient compensated.
  - 5) Automatic resetting.
- g. Solid-State Overload Relay:
  - 1) Switch or dial selectable for motor running overload protection.
  - 2) Sensors in each phase.
  - 3) [Class 10] [Class 20] [Class 10/20 selectable] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing. <Engineer to Edit for Project Requirements>
  - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
  - 5) Analog communication module.
- h. [N.C.] [N.O.], isolated overload alarm contact. <Engineer to Edit for Project Requirements>

- i. External overload reset push button.
- C. Combination Reduced-Voltage Solid-State Controller: Factory-assembled combination of reduced-voltage solid-state controller, OCPD, and disconnecting means.
1. Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
    - a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    - b. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - c. Rockwell Automation, Inc.; Allen-Bradley brand.
    - d. Siemens Energy & Automation, Inc.
    - e. Square D; a brand of Schneider Electric.
    - f. <Insert manufacturer's name>.
  2. MCP Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
    - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
    - d. [N.C.] [N.O.] alarm contact that operates only when MCP has tripped. <Engineer to Edit for Project Requirements>
    - e. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
  3. MCCB Disconnecting Means:
    - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
    - b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
    - c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
    - d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
    - e. [N.C.] [N.O.] alarm contact that operates only when MCCB has tripped. <Engineer to Edit for Project Requirements>
  4. Molded-Case Switch Disconnecting Means:



- a. UL 489, NEMA AB 1, and NEMA AB 3, with in-line fuse block for Class J or L power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
- b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.
- d. [N.C.] [N.O.] alarm contact that operates only when molded-case switch has tripped. <Engineer to Edit for Project Requirements>

## 2.4 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
  1. Dry and Clean Indoor Locations: Type 1.
  2. Mechanical and Electrical Rooms: Type 12.
  3. Outdoor Locations: Type 4X non-metallic.
  4. [Kitchen] [Wash-Down] Areas: Type 4X non-metallic. <Engineer to Edit for Project Requirements>
  5. Other Wet or Damp Indoor Locations: Type 12.
  6. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
  7. Hazardous Areas Indicated on Drawings: [Type 7] [Type 9] <Insert type>.

## 2.5 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
  1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty type.
    - a. Push Buttons: [Covered] [Lockable] [Recessed] [Shielded] [Shrouded] [Unguarded] types; [maintained] [momentary] as indicated.
    - b. Pilot Lights: LED types; colors as indicated[; push to test].
    - c. Selector Switches: Rotary type.  
<Engineer to Edit for Project Requirements>
  2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
- B. [N.C.] [N.O.] [Reversible N.C./N.O.] auxiliary contact(s). <Engineer to Edit for Project Requirements>
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.



- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Breather and drain assemblies, to maintain interior pressure and release condensation in [Type 4X] [Type 7] [Type 9] <Insert type> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- F. Space heaters, with N.C. auxiliary contacts, to mitigate condensation in [Type 3R] [Type 4X] [Type 12] <Insert type> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- H. Cover gaskets for Type 1 enclosures.
- I. Terminals for connecting power factor correction capacitors to the load side of overload relays.
- J. Spare control wiring terminal blocks, quantity as indicated; wired.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounted Controllers: Install enclosed controllers on four (4) inch nominal-thickness concrete base. Comply with requirements for concrete base specified in

Division 03 Section "[Cast-in-Place Concrete] [Miscellaneous Cast-in-Place Concrete]."  
<Engineer to Edit for Project Requirements>

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on eighteen (18) inch centers around the full perimeter of concrete base.
  2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- E. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Install power factor correction capacitors. Connect to the [line] [load] side of overload relays. If connected to the load side of overload relays, adjust overload heater sizes to accommodate the reduced motor full-load currents. <Engineer to Edit for Project Requirements>
- H. Comply with NECA 1.

### 3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  2. Label each enclosure with engraved nameplate.
  3. Label each enclosure-mounted control and pilot device.

### 3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices [and facility's building automation system]. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables." <Engineer to Edit for Project Requirements>
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation. [Test and adjust controllers, components, and equipment.] <Engineer to Edit for Project Requirements>
  - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at controller locations are within plus or minus 10 % of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
  - 5. Test each motor for proper phase rotation.
  - 6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller eleven (11) months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six (6) times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or eleven (11) times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at [50] [65] [80] percent.  
<Engineer to Edit for Project Requirements>

- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
- F. Set field-adjustable circuit-breaker trip ranges[.][ as specified in Division 26 Section "Overcurrent Protective Device Coordination Study." <Engineer to Edit for Project Requirements>

### 3.7 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers [, and to use and reprogram microprocessor-based, reduced-voltage solid-state controllers] <Engineer to Edit for Project Requirements>

END OF SECTION 262913