

SECTION 26 24 19 LOW-VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which shall be followed for this section:
1. Institute of Electrical and Electronics Engineers (IEEE):
 - a. C2, National Electrical Safety Code (NESC).
 - b. C37.20.7, Guide for Testing Metal Enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults.
 2. National Electrical Contractors Association (NECA): 402, Standard for Installing and Maintaining Motor Control Centers.
 3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
 - b. ICS 1, Industrial Control and Systems: General Requirements.
 - c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.
 - d. ICS 2.3, Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600V.
 - e. ICS 18, Motor Control Centers.
 - f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 5. UL:
 - a. 98, Enclosed and Dead-Front Switches.
 - b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - c. 845, Motor Control Centers.

1.02 DEFINITIONS

- A. LCD: Liquid Crystal Display.
- B. N.C.: Normally Closed.
- C. N.O.: Normally Open.
- D. SPD: Surge Protection Device.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Itemized Bill of Material.
3. Dimensional drawings including network cable barrier locations.
4. Front Panel Elevations.
5. Conduit entrance locations.
6. Bus data.
7. Protective Devices: Copies of time-current characteristics.
8. Interior Network/Communication cabling and components.
9. Communications protocol setup and parameter setting information for plant control system communication programming.
10. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
11. Anchoring instructions and details.
12. Typed Tabulation:
 - a. Motor name: tag (equipment) numbers as shown on the Drawings.
 - b. Motor horsepower.
 - c. Nameplate full load current.
 - d. Measured load current and voltage.
 - e. Overload model number and setting.
 - f. Protective device trip settings.
 - g. Manufacturer's solid state starter switch or dip switch or program settings.
 - h. Attach above typed, tabulated data to a copy of starter manufacturer's overload relay or setting selection tables for starters provided.
13. Diagrams:
 - a. Control diagrams.
 - b. One-line diagrams.
 - c. Schematic (elementary) diagrams.
 - d. Outline diagrams.
 - e. Interconnection diagrams.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's installation instructions.
3. Factory test reports, certified.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

- A. Provide products manufactured within scope of UL that conform to UL Standards and have applied UL Listing Mark.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Shipping Splits: Established by Contractor to facilitate ingress of equipment to final installation location within building.

PART 2 PRODUCTS

2.01 SEPARATELY-MOUNTED MOTOR CONTROL – MANUALLY OPERATED STARTER, FRACTIONAL HORSEPOWER

A. Physical Characteristics:

1. Finish: Manufacturer's standard.
2. Make necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors provided under this Contract.
3. Enclosure: NEMA 250, Type 4 or as shown.
4. Indicating Light: Red.
5. Handle guard/lock-off.
6. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.
7. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

B. Functional Characteristics:

1. Rating: 16 amperes continuous at 277 volts maximum.
2. Single-phase, nonreversing, full voltage with overload protection.
3. Toggle operated.

C. Performance Characteristics:

1. Operating Conditions:
 - a. Ambient Temperature: Maximum 40 degrees C.
 - b. Altitude: 7,500 feet above sea level.
 - c. Equipment to be fully rated.

2.02 SEPARATELY MOUNTED MOTOR CONTROL – MANUALLY OPERATED STARTER, INTEGRAL HORSEPOWER

A. Physical Characteristics:

1. Finish: Manufacturer's standard.
2. Enclosure: NEMA 250, Type 4 or as shown on the Drawings.

B. Functional Characteristics:

1. Rating: Horsepower rated to maximum of 10 hp at 600 volts with thermal overload protection.
2. Single-phase or three-phase, nonreversing, full voltage.
3. Control: Toggle or pushbutton.
4. Red pilot light.
5. Locking in OFF position.
6. Two spare auxiliary, field-changeable contacts.

C. Performance Characteristics:

1. Operating Conditions:
 - a. Ambient Temperature: Maximum 40 degrees C.
 - b. Altitude: 7,500 feet above sea level.
 - c. Equipment to be fully rated.

2.03 SEPARATELY MOUNTED MOTOR CONTROL – COMBINATION FULL-VOLTAGE, MAGNETIC STARTER

A. Physical Characteristics:

1. Enclosure: NEMA Type 4 or as shown on the Drawings.
2. Finish: Manufacturer's standard.

B. Functional Characteristics:

1. Horsepower rated at 600 volts; UL labeled for 22,000 amperes at 480 volts short circuit capacity with solid-state overload protection.
2. Three-phase, non-reversing, full voltage.
3. Control: As shown on the Drawings.
4. Disconnect Type: Motor Circuit Protector (MCP).
5. Padlockable operating handle, capable of up to three locks.

C. Performance Characteristics:

1. Operating Conditions:
 - a. Ambient Temperature: Maximum 40 degrees C.
 - b. Altitude: 7,500 feet above sea level.
 - c. Equipment to be fully rated.

2.04 SEPARATELY MOUNTED MOTOR CONTROL – COMBINATION REDUCED VOLTAGE, SOLID STATE STARTER

A. Physical Characteristics:

1. Enclosure: NEMA Type 4 or as shown on the Drawings.
2. Finish: Manufacturer's standard.

B. Functional Characteristics:

1. Horsepower rated at 600 volts, UL labeled for 22,000 amperes at 480 volts short circuit capacity with solid-state overload protection.
2. Three-phase, non-reversing.
3. Solid-state Reduced Voltage Starter:
 - a. Class 10/20/30 electronic overload relay.
 - b. Kick start, with adjustable torque and time settings.
 - c. Ramp start, selectable current or torque, and adjustable time.
 - d. Smooth stop ramp, adjustable time.
 - e. Phase loss unbalance and phase reversal protection.
4. Control: As shown on the Drawings.
5. Disconnect Type: Motor Circuit Protector (MCP).
6. Padlockable operating handle, capable of up to three locks.

C. Performance Characteristics:

1. Ambient Temperature: Maximum 40 degrees C.
2. Altitude: 7,500 feet above sea level.
3. Equipment to be fully rated.

2.05 SEPARATELY MOUNTED MOTOR CONTROL – COMBINATION REVERSING, MAGNETIC STARTER

A. Physical Characteristics:

1. Enclosure: NEMA Type 4 or as shown on the Drawings.
2. Finish: Manufacturer's standard.

B. Functional Characteristics:

1. Horsepower rated at 600 volts, UL labeled for 22,000 amperes at 480 volts short circuit capacity with solid-state overload protection.
2. Three-phase, reversing, full voltage.
3. Control: As shown on the Drawings.
 - a. Indicating Lights:
 - 1) Red: RUNNING.
 - 2) Amber: REVERSE.

4. Disconnect Type: Motor Circuit Protector (MCP).
5. Padlockable operating handle, capable of up to three locks.

C. Performance Characteristics:

1. Ambient Temperature: Maximum 40 degrees C.
2. Altitude: 7,500 feet above sea level.
3. Equipment to be fully rated.

2.06 SOLID STATE MOTOR OVERLOAD PROTECTION

A. Physical Characteristics:

1. Provide in each ungrounded phase.
2. Mount within starter enclosure.

B. Functional Characteristics:

1. Current-operated electronic circuitry with adjustable trip.
2. Inverse-time Characteristics: Class 10 (quick), Class 20 (standard), Class 30 (slow), field selectable.
3. Phase loss, unbalanced phase, and Class II ground fault protection.
4. Normally open (N.O.) auxiliary contact for remote monitoring and control. Manual reset.
5. Communication: Data interface to SCADA network.

C. Performance Characteristics:

1. Ambient Temperature: Maximum 40 degrees C.
2. Altitude: 7,500 feet above sea level.
3. Equipment to be fully rated.

2.07 MOTOR CONTROL CENTERS

A. Physical Characteristics:

1. Enclosures: In accordance with NEMA 250.
2. Type: Type 1, indoor.
3. Finish: Manufacturer's standard.
4. Lifting lugs on equipment and devices weighing over 100 pounds.
5. Make necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors provided under this Contract.

6. Vertical Section Standard Indoor Dimensions for NEMA 1 Type:
 - a. Nominal, 90 inches high, 20 inches wide, 21 inches deep.
 - b. Alternative width dimensions of 24 inches and 30 inches are acceptable for oversize devices or panels.
 - c. Do not exceed space shown.
7. Construction:
 - a. Sheet steel reinforced with channel or angle irons.
 - b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
 - c. Removable top cover plates and bottom cover plates.
 - d. Removable plates on end panels for future bus extension.
8. Section Mounting: Removable formed-steel channel sills and lifting angles to meet specified seismic requirements.
9. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
10. Vertical Wiring Compartment:
 - a. Full height, isolated from unit starters with separate hinged door and tie supports.
 - b. No terminal blocks allowed in vertical wireway compartment.
 - c. Provide separate low-level signal/network raceway in wireway.
11. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.
12. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
13. Door Interlocking: Mechanically interlock starter and feeder doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access and energizing at any time by qualified individual.
14. External disconnect handles with ON/OFF and trip positions showing, padlockable in OFF position with up to three-lock capability.
15. Cable Entrance: Main leads enter from top bottom; control and feeder circuits enter from top and bottom.
16. Incoming Service Feeder: Cable.
17. Mechanical type CU-/AL lugs for 75 degrees C cable.
18. For MCC's with main breakers that can be adjusted to 1200 amperes or higher shall be provided with an energy-reducing maintenance switch with local indicator.

B. Functional Characteristics:

1. In accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 18, and UL 845.
2. Voltage Rating: 600 volts.

3. Main Circuit Breaker:
 - a. Solid State Trip Circuit Breaker:
 - 1) In accordance with UL 489.
 - 2) Main protective device: Devices that can be adjusted to 1200 amperes or higher shall be provided with an energy-reducing maintenance switch with local indicator.
 - 3) Insulated or molded case breakers with ambient insensitive solid-state trips and having current sensors and logic circuits integral in breaker frame.
 - 4) Solid-state current control with adjustable ampere setting, adjustable long-time delay, adjustable short-time trip and delay band, fixed or adjustable instantaneous trip, and adjustable ground fault trip and delay band.
 - 5) Setting adjustments to be covered by a sealable, tamper-proof, transparent cover (insulated case breakers only) or by compartment door for other breakers).
 - 6) Locate trip button on front cover of breaker to permit mechanical simulation overcurrent tripping for test purposes and to trip breaker quickly in an emergency situation.
4. Control Transformer:
 - a. Two winding, 120-volt secondary, primary voltage to suit.
 - b. Two current-limiting fuses for primary circuit.
 - c. One fuse in secondary circuit with blown fuse indicator.
 - d. Mount within starter unit.
5. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
6. Anchor Bolts: Galvanized, or Type 316 stainless steel, sized seismically by a licensed structural engineer registered in the state where equipment is to reside, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.
7. Seismic Zone and Importance Factor: As specified in Section 01 67 00, Product Requirements.
8. Provide an Ethernet/IP communications network within the motor control center to interconnect all solid state overloads, adjustable frequency drives, and metering devices equipped with communications.
9. Ethernet/IP equipped MCCs shall have a minimum of one network switch per shipping split, connected together for incorporation into a single drop based external network.
10. Provide a separate 120V, single-phase circuit, backed by UPS, to the MCC structure for powering a 24V dc power supply, installed inside the MCC:
 - a. Power Supply: Provide all power required for networking devices associated with the MCC communications network.
11. Provide network devices, cabling, and connectors ODVA compliant for Ethernet/IP networks.

12. Short Circuit Rating: 65,000 amperes rms symmetrical at 480 volts for entire motor control center as a complete assembly.
13. Main and branch circuit breakers, controllers, wire connections, and other devices to be front mounted and accessible, unless otherwise noted.
14. NEMA ICS 18, Part 3:
 - a. Class II.
 - b. Type B.
 - c. Wire remote control and signal circuits to separate terminal board compartment in each motor control center lineup.
 - d. Provide blank spaces on interconnection diagrams to add control conductor code designations during installation of equipment.
15. Horizontal Power Bus:
 - a. Three-phase tin-plated or silver-plated, copper, entire width of control center, rated as shown.
 - b. Construct to allow future extension of additional sections.
 - c. Pressure type solderless lugs for each incoming line cable.
 - d. Isolated from top horizontal wireway.
16. Vertical Power Bus:
 - a. Three-phase tin-plated or silver-plated, copper, full height of section, rated 300 amperes.
 - b. Insulated and isolated barrier, complete with shutters.
17. Neutral Bus: None.
18. Ground Bus: Copper, bare tin-plated or silver-plated, rated 600 amperes, entire width of control center and in each vertical wireway.
19. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, motor start counters, and elapsed time meters as specified in Section 26 05 04, Basic Electrical Materials and Methods.
20. Construction:
 - a. Bolt-on combination type with cable connection to riser for starters NEMA ICS.
 - b. Readily interchangeable with starters of similar size.
 - c. Pull-apart unit control wiring terminal boards capable of accepting up to two 14 AWG wires minimum on drawout units.
21. Control Devices: As indicated and as specified in Section 26 05 04, Basic Electrical Materials and Methods.
22. Control Wiring:
 - a. Copper, 14 AWG, minimum.
 - b. Permanent sleeve type markers with wire numbers applied to each end of wires.
 - c. Terminate wires using insulated locking fork or ring type crimp terminals.
 - d. Terminate current transformer leads on shorting type terminal blocks.

23. Motor Controller Communications:
- a. Communicate the following commands and status with the plant control system via the Ethernet/IP network:
 - 1) Receive Commands:
 - a) RUN/STOP.
 - b) SPEED (Adjustable Frequency Drives Only).
 - 2) Status Feedback:
 - a) STOPPED/RUNNING.
 - b) LOCAL/REMOTE.
 - c) SPEED (Adjustable Frequency Drives Only).
 - d) FAIL.
 - e) Current.
 - f) Line Voltage.
 - b. Communication Devices: Connect to the Plant Control System as shown on the Network Block Diagrams in the Contract Documents.
24. Starters:
- a. NEMA ICS 18, standard rating, except none smaller than NEMA ICS, Size 1.
 - b. Rating: Horsepower rated at 600 volts, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
 - c. Three-phase, nonreversing, unless specified otherwise.
 - d. Disconnect Type: Motor circuit protector.
 - e. Combination Full Voltage, Magnetic Starter:
 - 1) Control: As shown on the Drawings.
 - 2) Pilot Lights: Red–ON.
 - f. Combination Reduced Voltage, Solid State Starter:
 - 1) Control: As shown on the Drawings.
 - 2) Bypass contactor.
 - 3) Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
 - 4) Kick start, with adjustable torque and time settings.
 - 5) Ramp start, selectable current or torque, and adjustable time.
 - 6) Smooth stop ramp, adjustable time.
 - 7) Phase loss unbalance and phase reversal protection.
 - 8) LED display or LCD of fault, N.O. contact to communicate fault condition.
 - g. Combination Reversing, Magnetic Starter:
 - 1) Control: As shown on the Drawings.
 - 2) Suitable for squirrel cage motors.
 - 3) Pilot Lights: Green–OFF, Red–FORWARD, Amber–REVERSE.
 - h. Combination Adjustable Frequency Drive, Solid State Starter: Drives as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

- i. Communications: Ethernet interface capability to computer.
 - j. Padlockable operating handle when de-energized with up to three-lock capability.
 - k. Unit door interlocked to prevent opening when disconnect is in CLOSED position.
 - l. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.
 - m. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.
25. Disconnecting Device:
- a. As indicated.
 - b. Padlockable in OPEN position for up to three locks.
26. Feeder Circuit Breaker:
- a. Meet requirements of UL 489.
 - b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
 - c. Thermal-magnetic trip.
 - d. Tripping indicated by operating-handle position.
 - e. Interrupting capacity required for connection to system with short-circuit capacity indicated.
27. Fused Switch:
- a. Heavy-duty, motor rated, load-break, quick-make, quick-break type meeting requirements of UL 98 and NEMA KS 1.
 - b. Current-limiting fuses, with rejection clips.
28. Load Detector Relay: Manual reset with adjustable differential.
29. Solid State Motor Overload Protection:
- a. For motors rated 1/2 hp and greater.
 - b. Inverse-time-limit characteristic.
 - c. Phase loss, phase unbalance and Class II ground fault protection.
 - d. Current operated electronic circuitry with adjustable trip.
 - e. Class 10/20/30 relay trip, switch selectable.
 - f. One N.O. auxiliary contact for remote monitoring.
 - g. Manual reset.
 - h. Provide in each ungrounded phase.
 - i. Input/Output Features:
 - 1) Receive Commands:
 - a) Digital Outputs: RUN.
 - 2) Status Feedback:
 - a) Digital Inputs: Minimum of four input points.
 - (1) In REMOTE.
 - (2) RUNNING.
 - (3) FAULT.
 - (4) User programmable.
 - j. Mount within starter unit.
 - k. Communications: Ethernet interface capability to computer.

30. Motor Thermal Protector Interface: Manual-reset interposing relay for connection to motor-mounted thermal protector system.
31. Digital Instruments: Digital Power Meter: As specified in Section 26 09 13, Power Measurement and Control.
32. SPD: As specified in Section 26 43 00, Surge Protection Devices.
33. Pushbuttons, Indicating Lights, Selector Switches, Elapsed Time Meters, Control Relays, Time-Delay Relays, and Reset Timers: As specified in Section 26 05 04, Basic Electrical Materials and Methods.
34. Nameplates:
 - a. As specified in Section 26 05 02, Basic Electrical Requirements.
 - b. Provide for each motor control center and each unit.
 - c. Engrave with inscription shown on single-line diagram.
 - d. Provide blank nameplates on spaces for future units.
 - e. Attach with stainless steel panhead screws on face of control center.
35. Space Heaters: Thermostatically controlled. Locate in bottom of each vertical section for operation from 120-volt power source derived internal to MCC.

C. Performance Characteristics:

1. Operating Conditions:
 - a. Ambient Temperature: Maximum 40 degrees C.
 - b. Altitude: 7,500 feet above sea level.
 - c. Equipment to be fully rated.

2.08 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Applicable Standards: NEMA ICS 18, UL 845, and NEC Article 430, Part VIII.
2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.
3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.
4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.
5. Control Circuits and Devices:
 - a. Energize circuit at rated voltage.
 - b. Operate control devices.
 - c. Perform continuity check.

6. Instruments, Meters, Protective Relays, and Equipment:
 - a. Verify devices functioned by energizing potential to rated values with connection to devices made at outgoing terminal blocks.
 - b. Verify protective relays operated for functional checks and trips manually initiated to verify functioning of operation for indicator and associated circuits.
7. Perform dielectric tests on primary circuits and equipment, except potential transformers.
 - a. Tests: Phase-to-phase and phase-to-around with 60-cycle test voltages applied for 1 second at 2,640 volts.
8. Verify equipment passed tests and inspection.
9. Provide standard factory inspection and test checklists, and final certified and signed test report.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer's written instructions and recommendations.
2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
3. Install equipment plumb and in longitudinal alignment with pad or wall.
4. Coordinate terminal connections with installation of secondary feeders.
5. Grout mounting channels into floor or mounting pads.
6. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.
7. Motor Data:
 - a. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
 - 1) Motor served by tag number and equipment name.
 - 2) Nameplate horsepower.
 - 3) Motor code letter.
 - 4) Full load amperes.
 - 5) Service factor.
 - 6) Installed overload relay catalog number.

B. Circuit Breakers:

1. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.
2. Adjust to approximately 11 times motor rated current.

3. Determine motor rated current from motor nameplate following installation.

C. Thermal Overload Relay:

1. Select and install overload relays and apply settings after actual nameplate full-load current rating of motor has been determined.
2. Initial Settings: In accordance with manufacturer's recommendation.

3.02 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with Section 01 79 00, Demonstration and Training, for the following services at Job Site or classroom as designated by Contracting Officer, for minimum person-days listed below, travel time excluded:

1. 2 person-days for installation assistance, and inspection of installation.
2. 1 person-day for functional and performance testing.
3. 1 person-day for plant startup.
4. 1 person-day for training of Government's personnel.

END OF SECTION