

SECTION 26 29 11
LOW-VOLTAGE MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

All motor starters and motor control stations including installation and connection (whether furnished with the equipment specified in other Divisions or otherwise) shall meet these specifications.

1.2 RELATED WORK

- A. Other sections which specify motor driven equipment, except elevator motor controllers.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 SUBMITTALS

Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

- A. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.
- B. Manuals:
 - 1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams and information for ordering replacement parts.
 - a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance and operation.
 - b. Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
 - c. Elementary schematic diagrams shall be provided for clarity of operation.
 - 2. Two weeks prior to the project final inspection, submit four copies of the final updated maintenance and operating manual to the C.O.R.. (Update manual to include any information necessitated by shop drawing approval).
- C. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the C.O.R.:
 - 1. Certification by the manufacturer that the controllers have passed the factory 24-hour operational test. (This certification must be furnished to the C.O.R. prior to shipping the controller to the job site.)

2. Certification by the manufacturer that high voltage motor controller(s) conforms to the requirements of the drawings and specifications. (This certification must be furnished to the C.O.R. prior to shipping the controller to the job site.).
3. Certification that the equipment has been properly installed, adjusted, and tested.

1.4 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.
- B. Institute of Electrical and Electronic Engineers (IEEE):
 - 519-92Recommended Practices and Requirements for Harmonic Control in
Electrical Power Systems
 - C37.90.1-02.....Standard Surge Withstand Capability (SWC) Tests for Protective
Relays and Relay Systems
- C. National Electrical Manufacturers Association (NEMA):
 - ICS 1-00Industrial Control and Systems General Requirements
 - ICS 1.1-03Safety Guidelines for the Application, Installation and Maintenance of
Solid State Control
 - ICS 2-00Industrial Control and Systems, Controllers, Contactors and Overload
Relays Rated 600 Volts DC
 - ICS 6-01Industrial Control and Systems Enclosures
 - ICS 7-00Industrial Control and Systems Adjustable-Speed Drives
 - ICS 7.1-00Safety Standards for Construction and Guide for Selection, Installation
and Operation of Adjustable-Speed Drive Systems
- D. National Fire Protection Association (NFPA):
 - 70-2011National Electrical Code (NEC)
- E. Underwriters Laboratories Inc. (UL):
 - 508-99Industrial Control Equipment\

PART 2 - PRODUCTS

2.1 MOTOR STARTERS, GENERAL

- A. Motor starters shall be in accordance with the requirements of the IEEE, NEC, NEMA (ICS 1, ICS 1.1, ICS 2, ICS 6, ICS 7 and ICS 7.1) and UL.
- B. Shall have the following features:
 1. Separately enclosed unless part of another assembly.
 2. Circuit breakers and safety switches within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
 3. Motor control circuits:

- a. Shall operate at not more than 120 volts.
 - b. Shall be grounded except as follows:
 - 1) Where isolated control circuits are shown.
 - 2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.
 - c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.
 - d. Incorporate over current protection for both primary and secondary windings of the control power transformers in accordance with the NEC.
4. Overload current protective devices:
 - a. Overload relay (solid state type).
 - b. One for each pole.
 - c. Manual reset on the door of each motor controller enclosure.
 - d. Correctly sized for the associated motor's rated full load current.
 - e. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.
 - f. Deliver four copies of a summarized list to the C.O.R., which indicates and adequately identifies every motor controller installed. Include the catalog numbers for the correct sizes of protective devices for the motor controllers.
5. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular starter. H-O-A switch is not required for manual motor starters.
6. Incorporate into each control circuit a 120-volt, solid state time delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time delay relay is not required where H-O-A switch is not required.
7. Auxiliary contacts, pilot lights, pushbuttons and other devices and accessories as shown on the drawings or otherwise required.
8. Enclosures:
 - a. Shall be the NEMA types shown on the drawings for the motor controllers.
 - b. Shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.
 - c. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open. Provision for padlock must be provided.
 - d. Enclosures shall be primed and finish coated at the factory with the manufacturer's prime coat and standard finish.
- C. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.

- D. For motor controllers being installed in existing motor control centers or panelboards, coordinate with the existing centers or panelboards.
- E. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.
- F. Provide a disconnecting means or safety switch near and within sight of each motor. Provide all wiring and conduit required to facilitate a complete and code complied installation.
- G. Refer to paragraph, MOTOR CONTROL STATIONS, in this section for additional requirements.

2.2 MANUAL MOTOR STARTERS

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Manual motor starters.
 - 1. Starters shall be AC, general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
 - 2. Units shall include overload and low voltage protection, red pilot light, and toggle operator.
- C. Fractional horsepower manual motor starters.
 - 1. Starters shall be AC, general-purpose Class A, manually operated with full voltage controller for fractional horsepower induction motors.
 - 2. Units shall include thermal overload protection, red pilot light and toggle operator.
- D. Motor starting switches.
 - 1. Switches shall be AC, general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
 - 2. Units shall include thermal overload protection, red pilot light, low voltage protection, and toggle operator.

2.3 MAGNETIC MOTOR STARTERS

- A. Shall be in accordance with applicable requirements of 2.1 above.
- B. Starters shall be AC, general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum size 0.
- C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.
- D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

2.4 REDUCED VOLTAGE MOTOR CONTROLLERS

- A. Shall be in accordance with applicable portions of 2.1 above.
- B. Shall be installed where shown for motors on the contract drawings.
- C. Shall be the type shown on the drawings or included in Section 21 10 00, WATER-BASED FIRE SUPPRESSION SYSTEMS.
- D. Shall have closed circuit transition for the types which can incorporate such transition.
- E. Shall limit inrush currents to not more than 70 percent of the locked rotor currents.

- F. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

2.5 VARIABLE SPEED MOTOR CONTROLLERS

- A. Shall be in accordance with applicable portions of 2.1 above.
- B. Shall be solid state, micro processor-based with adjustable frequency and voltage, three phase output capable of driving standard NEMA B design, three phase alternating current induction motors at full rated speed. The drives shall utilize a full wave bridge design incorporating diode rectifier circuitry with pulse width modulation (PWM). Other control techniques are not acceptable. Silicon controlled rectifiers (SCR) shall not be used in the rectifying circuitry. The drives shall be designed to be used on variable torque loads and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.
- C. Shall be rated for input power of 480 volts, three phase, 60 Hz. Unit shall be capable of operating within voltage parameters of plus 10 to minus 10 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.
- D. Each controller shall be factory tested at maximum watts (HP), rated full load current and at an ambient temperature of 40 degrees C for a period of not less than 24 hours. If a component fails, it shall be replaced and the test restarted for the full time period. A certified copy of the factory Test Report shall be furnished to the Resident Engineer prior to shipping the controller to the job site.
- E. Controllers shall have the following features:
 - 1. Isolated power for control circuits.
 - 2. Manually re-settable motor overload protection for each phase.
 - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
 - 4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 30 seconds. (Set timers to the equipment manufacturer's recommended time in the above range.)
 - 5. Provide 4 to 20 ma current follower circuitry for interface with mechanical sensor devices.
 - 6. Automatic frequency adjustment from 20 Hz to 60 Hz.
 - 7. Provide circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The controller shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected:
 - a. Incorrect phase sequence.
 - b. Single phasing.
 - c. Over voltage in excess of 10 percent.
 - d. Under voltage in excess of 10 percent.
 - e. Running over current above 110 percent (shall not automatically reset for this condition.)
 - f. Instantaneous overcurrent above 150 percent (shall not automatically reset for this condition).
 - g. Surge voltage in excess of 1000 volts.

- h. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
- 8. Provide automatic shutdown on receipt of a power transfer warning signal from an automatic transfer switch. Controller shall automatically restart motor after the power transfer.
- F. Minimum efficiency shall be 95 percent at 100 percent speed and 85percent at 50 percent speed.
- G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.
- H. Controllers shall include a door interlocked fused safety disconnect switch or door interlocked circuit breaker switch which will disconnect all input power.
- I. Include a by-pass starter with circuitry to protect and isolate the variable speed controller. When the variable speed controller is in the by-pass mode, the solid-state components shall be isolated from the power supply on both the line and motor side.
- J. The following accessories are to be door mounted:
 - 1. AC Power on light.
 - 2. Ammeter (RMS motor current).
 - 3. HAND-OFF-AUTOMATIC switch.
 - 4. Manual speed control in HAND mode.
 - 5. System protection lights indicating that the system has shutdown and will not automatically restart.
 - 6. System protection light indicating that the system has shutdown but will restart when conditions return to normal.
 - 7. Manual variable speed controller by-pass switch.
 - 8. Diagnostic shutdown indicator lights for each shutdown condition.
 - 9. Provide two N.O. and two N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
 - a. System shutdown with auto restart.
 - b. System shutdown without auto restart.
 - C. System running.
 - 10. Incorporate into each control circuit a 120-volt, time delay relay (ON delay), adjustable from 0.3-10 minutes, with transient protection. Provide transformer/s for the control circuit/s.
 - 11. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall transients from other devices on the AC power distribution system affect the controller.

Controllers shall be protected to comply with IEEE C37.90.1 and UL-508. Line noise and harmonic voltage distortion shall not exceed the values allowed by IEEE 519. Include Harmonic filter within the enclosure of the VFD.

2.7 MOTOR CONTROL STATIONS

- A. Shall have the following features:
 - 1. Designed for suitably fulfilling the specific control functions for which each station is being installed.

2. Coordinate the use of momentary contacts and maintained contacts with the complete motor control systems to insure safety for people and equipment.
 3. Each station shall have two pilot lights behind red and green jewels and a circuit to its motor controller. Connect the lamps so they will be energized as follows:
 - a. Red while the motor is running.
 - b. Green while the motor is stopped.
 4. Where two or more stations are mounted adjacent to each other, install a common wall plate, except where the designs of the stations make such common plates impracticable.
 5. Identify each station with a permanently attached individual nameplate, of laminated black phenolic resin with a white core and engraved lettering not less than 6 mm (1/4-inch) high. Identify the motor by its number or other designation and indicate the function fulfilled by the motor.
- B. Components of Motor Control Circuits:
1. Shall also be designed and arranged so that accidental faulting or grounding of the control conductors will not be able to start the motors.
 2. Use of locking type STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, will not be permitted.

2.8 PROVIDE INTERNALLY INTEGRATED SURGE PROTECTIVE DEVICES FOR EACH CONTROLLER:

- A. Integral Surge Suppressor:
1. SPD (Surge Protective Devices) shall be Component Recognized and listed in accordance with UL 1449 Second Edition to include Section 37.3 highest fault category testing on devices intended for service entrance use. SPD shall also be UL 1283 listed.
 2. SPD shall be UL 67 listed, installed by and shipped from the electrical distribution equipment manufacturer's factory.
 3. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, in WYE systems, and L-L, L-G in DELTA systems.
 4. SPD shall be modular in design. Each mode shall be fused with a 200kAIC; UL recognized surge rated fuse and incorporate a thermal cutout device.
 5. SPD shall be integrally mounted to the bus bars of the switchboard.
 6. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided as well.
 7. SPD shall meet or exceed the following criteria:
 - a. Maximum surge current capability (single pulse rated) per phase shall be:
 - 1) Service Entrance Switchboard 250 kA.
 - 2) Distribution Panelboards 160 kA
 - 3) Branch Panelboards 160 kA

- 4) Service Entrance MCC 240 kA specified.
- 5) Distribution Class MCC 160 kA
- b. UL 1449 Second Edition Listed and Recognized Component Suppression Voltage Ratings (SVR's) for Service Entrance and Distribution Location equipment shall not exceed the following:
- c. Voltage Let-Thru values for Solidly Grounded Systems:

VOLTAGE	L-N	L-G	N-G
208Y/120	400V	400V	400V
480Y/277	800V	800V	800V

- 8. SPD shall have a minimum EMI/RFI filtering of –50Db at 100 kHz with an insertion ratio of 50:1 using MIL-STD-220A methodology.
- 9. SPD shall have the following diagnostic features: transient counter, status lights on each phase, and one set of 1 NO and 1 NC auxiliary dry contacts for alarming.
- 10. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if transients destroy them during the warranty period. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.
- B. Install Variable Speed Motor Controllers in accordance with manufacturers recommendations, the NEC, as shown on the drawings and in accordance with NEMA ICS 7.1.C.
- C. Furnish and install heater elements in motor starters to match the installed motor characteristics.

3.2 SPARE PARTS

Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

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