SECTION 16480

LOW VOLTAGE MOTOR CONTROL CENTER

# GENERAL

## DESCRIPTION

### This section describes materials, testing, and installation of low-voltage motor control equipment.

## RELATED WORK SPECIFIED ELSEWHERE

### Section 16010: General Electrical Requirements.

### Section 16012: Seismic Restraint for Electrical Equipment.

### Section 16160: Panelboards

### Section 16250: Automatic Transfer Switch.

### Section 16460: Dry-Type Transformers.

### Section 16938: Power System Study.

### Section 17300: Instrumentation Control and Monitoring System.

## SUBMITTALS

### Submit shop drawings in accordance with the General Conditions.

### Submit manufacturer’s descriptive and technical literature.

### Complete electrical diagrams and catalog brochures shall be submitted to the Engineer for approval prior to fabrication. The submittal for the electrical controls shall include a layout dimension and weights; schematic diagram; a wiring diagram; an interconnection diagram; and a list of material that includes all control circuit subassemblies, parts, components, and devices and their manufacturer’s part number. Schematic, wiring, and interconnection diagrams shall be in AutoCAD.

### Terminal numbers shall be shown for all items in the motor control sections, all items in the control section, on all interconnection wiring, and on the interconnection wiring diagrams. Wiring from these numbered terminals must be shown to all control sections and remote devices with the connections on both ends clearly indicated on the schematic, wiring, and interconnection diagrams. Terminals on the remote devices shall be numbered and identified so that continuity may be checked by the DISTRICT and later verified in the field.

### Submit a CD with the as-built schematic, wiring, and interconnection diagrams in AutoCAD.

### Submit manufacturer's descriptive data including ratings, single-line diagrams, three-line diagrams, control schematic wiring diagrams, dimensional data, conduit entry restrictions, and overload heater ratings.

### Submit control schematic diagrams in a “ladder diagram” format that satisfy the following minimum requirements:

#### Show unique rung numbers on left side of each rung. Provide unique wire numbers for all wires between terminals. conform all control drawings and electrical / MCC drawings to reflect the same wire numbers for connection to / From TCP to MCC panel. Generic MCC wiring numbers is not acceptable. Contractor shall submit a conformed wiring package that uses the same wire numbers throughout the entire project.

#### Show terminal numbers for all devices, relays, timers, contacts, etc

#### Where the internal wiring diagrams of subassemblies are furnished on separate sheets, show as a rectangle in the schematic diagram with external points identified and cross-referenced to the separate sheets of the control circuit. Show coils and contacts internal to the subassemblies in the rectangle connected to their terminal points.

#### Use a cross-referencing system in conjunction with each relay coil so that associated contacts may be readily located on the diagram. Where a relay contact appears on a sheet separate from the one on which the coil is shown, describe the purpose of the contact on the same sheet. Show spare contacts.

#### Show symbols of external field devices on the schematic (ladder) diagram with utilities turned off (electric power, air, gas, oil, water, lubrication, etc.) and with the equipment at its normal starting position. If the equipment is shown in a specific position, identify the position.

#### Show contacts of multiple contact devices, e.g., selector switches, on the line of the schematic diagram where they are connected in a circuit. Indicate a mechanical connection between the multiple contacts by a dotted line or arrow. This does not apply to control relays, starter, or contactors. Use additional charts or diagrams to indicate the position of multiple contact devices.

#### Show the purpose or function of switches adjacent to the symbols. Show the purpose or function of controls such as relays, starter, contactors, solenoids, subassemblies, and timers on the diagram on the right side of the respective rung.

#### The starter manufacturer shall review the control schematic diagrams provided in the drawings, shall identify any adjustments that might be required to achieve the intended control features, and shall implement such changes, prior to shipping the equipment. If further adjustments are required, make such adjustments in the field, with the consent of the Owner’s Representative.

### Submit manufacturer’s test report of the factory tests. Describe each circuit, logic function, device, or item tested. Describe results of tests and retests. Describe corrective action taken on defective circuits, logic functions, and devices.

### Operation and Maintenance Manuals:

### Submit operation and maintenance manuals in accordance with Section 01783.

### Manufacturer’s Services:

### Provide equipment manufacturer’s services at the jobsite for a minimum of one Labor Day, travel time excluded:

### All functions and features identified in this specification are to be provided regardless of if they are a standard of the manufacturer. Acceptance of any submittal where required items were not included does not alleviate the Contractor from the need to provide the items per plans and specifications.

## RATINGS

### Motor horsepower ratings and enclosures shown are minimum expected. This does not limit the equipment size. When motors furnished differ from the minimum ratings indicated, make the necessary adjustments to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate the motors actually installed, at no additional cost to the DISTRICT.

## SPARE MATERIALS

### Provide the following spare parts delivered to the DISTRICT in the manufacturer’s original containers labeled to describe the contents and the equipment for which it is furnished for no additional costs to the DISTRICT:

#### Control Fuses: Five of each type provided.

#### Contactor: One of each size provided.

#### Solid-State Starter: One.

#### Control Relay: Five of each type provided.

#### Time Delay Relay: Five of each type provided.

#### Intrinsically Safe Relay: One.

#### Lamps: Twenty of each type provided.

#### Pump Motor Moisture Detection Control Unit: One.

#### Electronic Overload Relay: One.

#### Keypad for solid-state reduced voltage starter or VFD: One.

### Provide two spare NEMA Size 1 starters and one spare NEMA size 3 starter.

## MEASUREMENT AND PAYMENT

### Payment for the work in this section shall be included as part of the lump-sum bid amount stated in the Proposal.

# MATERIALS

## MOTOR CONTROL CENTERS

### Motor control centers shall be dead front, dead rear, floor standing, and front accessible NEMA 1 gasketed construction. The voltage and ampere rating and physical dimensions shall be as indicated in the drawings. Wiring shall be NEMA Class 3R, Type B, with wiring schematics showing field devices and connections. Tag control wiring within 2 inches of termination at each device and terminal board. Schematics shall also show terminal numbers and interior and field wire numbers. For location with corrosion potential, the auxiliary enclosure shall be NEMA 3RX (316 stainless steel). MCC shall be in compliance with UL 845 unless otherwise indicated on the drawings.

### Control wiring shall be fine stranded MTW wire with PVC insulation. Provide white insulation for neutral wires and green insulation for ground wires.

### Provide channel iron sills and removable lifting angles.

### Provide a separate vertical wiring compartment for each motor control center section. Provide cable supports and a hinged door separate from the unit starters.

### Provide individual compartments separated by steel barriers and with separate hinged doors for each starter, circuit breaker, or other unit. Locate equipment to enable termination of field wiring from front without equipment removal.

### Mechanically interlock starter and circuit breaker doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access while starter or circuit breaker is energized. Make provisions for padlocking external disconnect handles in the OFF position.

### Bus bars shall be tin-plated copper and braced to withstand the rms symmetrical short-circuit current ratings as shown in the drawings. Provide full horizontal bus rating for entire length of the motor control center. Do not taper the bus.

### Buses within starter, feeder, and spare cubicles shall be factory insulated.

### Provide a continuous, front accessible 300-ampere-minimum ground bus extended the full length of the motor control center.

### Feeder circuit breakers shall be molded-case type. Provide quick-make and quick-break toggle mechanism, inverse-time trip characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings and number of poles as indicated in the drawings. Provide breakers with fault current interrupting ratings equal to or greater than the motor control center short-circuit current rating shown in the drawings.

### All control wiring from remote devices shall terminate on a labeled terminal strip.

### Combination starters shall be as described in “Combination Magnetic Motor Starters” in this section.

### Each compartment shall have nameplates as specified in Section 16010.

### Motor control centers shall comply with applicable NEMA, UL, and ANSI standards for industrial control. Motor control centers shall be UL listed under UL 845.

### The complete assembly, including anchors, shall be capable of withstanding seismic forces per Section 16012.

### No components or terminals shall be mounted on sides of cubicles or in pull sections. Only mounting on back panels is acceptable. All devices shall be mounted without obstructions to be readily accessible. Any wiring between shipping splits shall be continuous. Splices, plugs, or intermediate terminations are not allowed.

### Starter cubicles shall have 12-inch vertical space in addition to the manufacturer’s recommended standard space.

### Motor control centers shall be Allen-Bradley Centerline, no equal.

### Provide a LED light inside relay control panel which operates whenever relay control panel door is opened.

### Wiring ducts shall be sized to provide 50% spare capacity after allowing for field wiring.

### Provide separate wiring ducts or cable bundles for analog signal cables from other a-c wiring.

## COMBINATION MAGNETIC MOTOR STARTERS

### Comply with NEMA ICS, Class A, and with NEC Article 430.

### Full voltage combination motor starters shall be circuit-breaker type equipped with adjustable magnetic-trip circuit breakers (motor circuit protectors) as noted in the drawings. The short-circuit rating shall be at least 65,000 amperes symmetrical at 480 volts. Where a higher short-circuit rating is shown in the drawings, provide combination starters with higher short-circuit rating or provide current-limiting type breakers or circuit breakers with current limiters to achieve the short-circuit rating.

### Solid-state controller shall be as described in the subsection on “Solid-State Controller.”

### Provide 120-volt control circuit transformer where indicated. Provide 200-volt-ampere spare capacity that is in addition to contactor load plus other loads specified. Fuse one side of secondary winding and ground other side. Provide primary winding fuses where shown in drawings. Transformer shall be NEMA ST1, machine tool grade with isolated secondary winding.

### The manufacturer shall verify the motor ratings and coordinate the starter overloads with the actual horsepower ratings of the motors installed.

### Provide externally operable overload relay reset buttons and disconnect operators.

### Provide solid-state overload relays for protection of the motors. The relay shall be listed under UL 508. The relay shall be ambient compensated and shall have the following features:

#### Self –powered.

#### Class 10, 15, or 20 selectable tripping characteristics

#### Manual or automatic reset.

#### Phase loss protection. The relay shall trip in two seconds or less under phase loss condition when applied to a fully loaded motor.

#### Visible trip indication.

#### Ground-fault protection.

#### One normally open and one normally closed isolated auxiliary contact.

#### Test button that operates the normally closed contact.

#### Test trip function that trips both the normally open and normally closed contacts.

#### Provide externally operable overload relay reset buttons and disconnect operators.

### Starters shall have nameplates as specified in Section 16010.

## SOLID-STATE CONTROLLERS

### The solid-state controller shall be a 6-SCR or more (30 pole or higher is preferred) compact and multifunctional device with a built-in overload protection and built-in bypass contactor. The solid-state controller shall be sized for 1.15 service factor of the motor fully rated for continuous operation for 50°C ambient. The control section shall be digital microprocessor based.

### The controller shall comply with the following requirements:

#### Dielectric withstand per UL-508.

#### Noise and RF immunity per NEMA ICS-2-230 and IEEE STD 472.

### Buses shall be factory insulated as specified in paragraph 2.01.

### Provide the following functions:

#### Soft Start with Selectable Kickstart.

#### Current Limit.

#### Soft Stop.

#### Phase rebalance.

#### Full Voltage Start

### The acceleration ramp time shall be selectable from 2 to 30 seconds.

### The initial torque shall be adjustable from 5% to 90% of locked rotor torque.

### Kickstart function shall provide an adjustable time pulse of current prior to the normal start mode. The current shall be held at 500% plus or minus of full load for an adjustable time. This feature shall be field defeatable.

### Provide the following protection during “starting” and “running” modes. When these conditions are detected, starting of the controller shall be inhibited or the controller shall be shut down if it is operating:

#### Start Fault (faulty SCR firing).

#### Line Fault (phase loss, open motor lead, shorted SCR).

#### Temperature Fault (SCR rated temperature exceeded).

#### Stalled Motor.

### Provide a built-in alphanumeric backlit LCD display that indicates the following status and fault conditions:

#### Voltage.

#### Current.

#### KW.

#### Stopped.

#### Ramping.

#### Stopping.

#### At speed.

#### Fault, including display of cause of fault.

#### Ethernet communications module for interface with the telemetry. Ensure CAT6 Ethernet cable is routed and installed to the Telemetery Control Panel (TCP). Communications protocol shall be Ethernet/IP.

### Provide a latch circuit for three-wire control. It shall also be possible to wire it for two-wire control.

### Include two Form C auxiliary contacts for customer use. The contacts shall change state instantaneously on a start command and when the logic completes the ramp-down feature. It shall be possible to reconfigure the system via a switch such that the contacts change state when the controller has determined that the motor is “up-to-speed” and when the motor starts to decelerate.

### Provide a Form C auxiliary dry contact for common fault signal.

### Soft Stop: The deceleration ramp time shall be selectable with settings from 2 to 60 seconds. This feature shall be field defeatable.

### Equip the controller with integral heatsink assemblies.

### Provide grounding provisions for the controller mounting flange.

### Incorporate integral fan(s) for forced air ventilation.

### Provide metal oxide varistors for transient protection.

### Equip controller with lugs to accept the wire sizes indicated in the drawings.

### The controller shall be capable of:

### 600% current rating, 10 seconds

### 450% current rating, 30 seconds

### The controller shall operate properly within the motor control center and at the temperature, humidity, and altitude of the project. Provide oversized starter and/or cabinet supply fans and vents to comply with this requirement.

### Provide 3-phase motor thermal overload relay protection for both normal and bypass configurations.

### Provide a phase rebalance feature which would regulate the individual phase output voltages from the controller to maintain equal 3-phase current to the motor.

### Provide Allen-Bradley SMC-Flex Smart Motor Controller, no equal.

## RELAYS AND MISCELLANEOUS CONTROL DEVICES

### Mount control switches, push buttons and indicator lights as detailed on the drawings. The interface panel door shall have full height piano hinge. In the interface panel, provide separate terminal boards and physical separation for controls associated with each pump. In the pump motor bucket, provide a 120vac control power transformer sized to support associated relay control circuit, heaters and any associated pump control or monitoring devices. Provide 200-volt-ampere spare capacity from the transformer in addition to other loads specified.

### Provide separate terminal blocks for current transformers. Label “Current transformers—de-energize prior to disconnecting.”

### Provide relays with the number of contacts shown on the schematic diagrams. Utilize additional contact blocks or relays to satisfy the required number of contacts shown at no additional cost to the DISTRICT.

### No control relays shall be mounted within the starter compartments.

### Control relays mounted within the interface panel shall be plug-in type with tube or square base and socket. Relays shall be UL component recognized with 10-ampere, NEMA B300 rated contacts and coil voltage, number of poles and pole arrangement as indicated in the drawings. Equip with pilot light and a manual override feature. All relays that fit the same bases shall be interchangeable. Provide Allen-Bradley Bulletin 700 Type HA, Square D Type KP, Cutler-Hammer Series D5, Idec RR series, or equal.

### Time-delay relays shall be UL listed with contacts rated 10-ampere noninductive load, 120 volts, with coil voltage, number of poles, pole arrangement, and maximum timing adjustment as indicated in the drawings. Relays shall be plug-in, solid-state type with timing knob adjustment. All relays that fit the same bases shall be interchangeable. Provide Potter Brumfield, Syracuse Electronics, ISSC, or equal.

### Time-delay relays with contacts indicated as instantaneous close time open (ICTO) or instantaneous open time close (IOTC) shall be solid-state digital timer with a self-contained adjustment potentiometer. Output contact shall be 5 amperes minimum. Relay shall be Allen-Bradley Bulletin 852S or equal.

### Control switches shall be 30-mm round, oiltight type, complete with legend plates and quantity of contact blocks required for the control function.

### Indicating lights shall be push-to-test, oiltight type, complete with color of lens indicated in drawings and legend plate. Provide 22-mm LED cluster lamps operating on 120-volt a-c.

### Elapsed time meters shall be synchronous motor driven, 0- to 99,999.9-hour range, nonreset type, suitable for semiflush, panel mounting. Provide General Electric Model KT-8 or equal.

### Moisture detection control unit shall interrupt motor operation when the moisture sensors detect an influx of moisture within the motor. Provide the relay with a test push button and pilot light to check the moisture sending components without simulating a leak. Unit shall be Warrick Controls Type 2800 or equal.

### Electronic Motor Protection Device. Provide Schneider Electric TesyST Model LTMER08MFM with voltage monitoring accessory module Model LTMEV40FM. Motor Controller shall be mounted in MCC Section with LTMCU HMI display mounted on MCC Section door. Current Transformers shall be provided with separate terminal blocks and labeled "Current Transformers - de-energize prior to disconnecting. "Provide a microprocessor-based power monitoring device. Device shall be Allen-Bradley Powermonitor 5000 M5 or equal. Device shall have the following features:

#### Continuous metering of the three phases of the electrical system.

#### It shall be possible to view on the module display the current, voltage, active power, reactive power, power factor, watt-hours, frequency, total harmonic distortion, and demand values.

#### A multiposition keypad shall give full front panel programmability.

#### All set points shall be stored in EEPROM for permanent storage.

#### Provide factory-installed Ethernet I/P communications card. Ensure CAT5 Ethernet cable is routed and installed to the Telemetery Control Panel (TCP).

### Provide a NEMA start rated bypass contactor where shown on the drawings. Provide a 3-phase solid-state overload relay with selectable trip class, manual/auto reset, and an additional overload contact for status monitoring. Allen-Bradley 193-EE with 193-ERR remote reset module as described in 2.04.1.1.

### Provide an auxiliary contact for the main breaker.

# EXECUTION

## INSTALLATION

### Install starters and controllers in the motor control center.

### Secure motor control centers to floors or mounting pads with anchoring identified in engineered calculations. Anchor bolts or concrete anchors shall be Type 304 stainless steel. Brace motor control center every 10 feet and within 3 feet of each end with 1/4-inch angle iron, P1000 Unistrut and fittings, or equal. The adjacent sections of the lineup shall also be bolted to each other per manufacturer’s recommendations. The back of the motor control center shall be mounted as close as possible to building wall to prevent buildup of debris behind the motor control center.

## FIELD TESTS

### Provide the services of a qualified factory-trained manufacturer’s representative to assist in testing and start-up of the equipment specified under this section, in accordance with manufacturer’s published start-up services. Additionally, perform the following minimum work under the technical direction of the manufacturer’s service representative, if not included in their published start-up services:

#### Verify that factory-set adjustable set points of solid-state starter are in accordance with the motor set point values recommended by the motor manufacturer, and adjust them as required.

#### Certify in writing that the equipment has been installed, adjusted, and tested in accordance with the motor and motor control center manufacturers’ recommendations. Controller and motor nameplate information, settings, and operating parameters shall be documented. Equipment shall be inspected prior to the generation of any reports.

### Test the operation of each interlock to verify that the interlock performs its function.

### Test system for correct execution of control logic. Adjust wiring connections in panel to correct errors.

### Operate each breaker and verify that all phases of each load are disconnected.

### Set adjustable trip circuit breakers two settings above the setting that causes the breaker to trip during motor starting. Do not adjust the setting above 1,300% of the motor nameplate current rating.

## FACTORY INSPECTION/TESTING

### Subject the motor control centers to a complete functionality test. Simulate remote inputs and outputs and verify correct operation. If requested by Engineer, perform these factory tests in the presence of the Owner’s Representative. Provide 10 days’ advance notice of test date.

### Set adjustable set points of the solid-state starters at motor manufacturer’s recommended values. Coordinate with motor manufacturer and obtain recommended set point values in writing. Document information in O&M manual.

### Provide travel costs for factory inspection of panel by the DISTRICT’s Representative prior to shipment.

END OF SECTION