SECTION 262913.06 - SOFT-START MOTOR CONTROLLERS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section includes soft-start motor controllers that are designed for reduced-voltage start and full-voltage run duty.

Enclosed soft-start controllers.

Combination soft-start controllers.

Bypass motor controller.

Enclosures.

Accessories.

Identification.

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. CPT: Control power transformer.
				2. FLA: Full-load current.
				3. MCCB: Molded-case circuit breaker.
				4. MCP: Motor circuit protector.
				5. NC: Normally closed.
				6. NO: Normally open.
				7. OCPD: Overcurrent protective device.
				8. SCCR: Short-circuit current rating.
				9. SCPD: Short-circuit protective device.
				10. SCR: Silicon-controlled rectifier.
			1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

* + - * 1. Shop Drawings: For each type of controller.

Include plans, elevations, sections, and mounting details.

Indicate dimensions, weights, required clearances, and location and size of each field connection.

Wire Termination Diagrams and Schedules: Include diagrams for signal and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.

Include features, characteristics, ratings, and factory settings of individual OCPD and auxiliary components.

* + - * 1. Product Schedule: For each enclosed controller.

Each installed soft-start controller type.

NRTL listing.

Factory-installed accessories.

Nameplate legends.

SCCR of integrated unit.

For each combination soft-start controller, include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

Listing document proving Type 2 coordination.

For each series-rated combination, state the listed integrated SCCR (withstand) of SCPDs and OCPDs by an NRTL acceptable to authorities having jurisdiction.

* + - * 1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.

Coordinate "Qualification Data" paragraph below and as may be supplemented in "Quality Assurance" Article.

* + - * 1. Qualification Data: For testing agency.

Retain "Seismic Qualification Data" paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 260548.16 "Seismic Controls for Electrical Systems." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Data: Certificates, for soft-start controllers, from manufacturer.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

* + - * 1. Source quality-control reports.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For soft-start controllers to include in operation and maintenance manuals.

Include the following:

Routine maintenance requirements for soft-start controllers and installed components.

Manufacturer's written instructions for testing and adjusting circuit-breaker and MCP trip settings.

Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage soft-start controllers.

Projects with multiple sizes and types of controllers might include different types of overload relays. Retain one or both subparagraphs below to suit type(s) of motor overload protection.

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 FLAs.

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. MAINTENANCE MATERIAL SUBMITTALS
				1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Fuses for Fused Switches: Equal to [**10**] <**Insert number**> percent of quantity installed for each size and type, but no fewer than [**three**] <**Insert number**> of each size and type.

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.

Indicating Lights: [**Two**] <**Insert number**> of each type and color installed.

Auxiliary Contacts: Furnish [**one**] <**Insert number**> spare(s) for each size and type of magnetic controller installed.

Power Contacts: Furnish [**three**] <**Insert number**> spares for each size and type of magnetic contactor installed.

<**Insert extra materials**>.

* + - 1. QUALITY ASSURANCE

Retain "Testing Agency Qualifications" paragraph below if Contractor selects testing agency or if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article.." See the Evaluations for discussion of NETA ATS and testing procedures.

* + - * 1. Testing Agency Qualifications: Accredited by NETA.

Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

* + - * 1. Equipment Qualifications For Products Other Than Those Specified:

At the time of submission provide written notice to the Director of the intent to propose an “or equal” for products other than those specified. Make the “or equal” submission in a timely manner to allow the Director sufficient time to review the proposed product, perform inspections and witness test demonstrations.

If products other than those specified are proposed for use furnish the name, address, and telephone numbers of at least 5 comparable installations that can prove the proposed products have performed satisfactorily for 3 years. Certify in writing that the Director’s Representative of the 5 comparable installations will allow inspection of their installation by the Director's Representative and the Company Field Advisor.

Make arrangements with the Director’s Representative of 2 installations (selected by the Director) for inspection of the installations by the Director's Representative. Also obtain the services of the Company Field Advisor for the proposed products to be present. Notify the Director a minimum of 3 weeks prior to the availability of the installations for the inspection, and provide at least one alternative date for each inspection.

Only references from the actual Director or Director’s Representative (Security Supervisor, Maintenance Supervisor, etc.) will be accepted. References from dealers, system installers or others, who are not the actual Director’s Representative of the proposed products, are not acceptable.

Verify the accuracy of all references submitted prior to submission and certify in writing that the accuracy of the information has been confirmed.

The product manufacturer shall have test facilities available that can demonstrate that the proposed products meet the contract requirements.

Make arrangements with the test facility for the Director's Representative to witness test demonstrations. Also obtain the services of the Company Field Advisor for the proposed product to be present at the test facility. Notify the Director a minimum of 3 weeks prior to the availability of the test facility, and provide at least one alternative date for the testing.

Provide written certification from the manufacturer that the proposed products are compatible for use with all other equipment proposed for use for this system and meet all contract requirements.

* + - * 1. Company Field Advisor: Secure the services of a Company Field Advisor from the Company providing the soft start motor controllers for a minimum of 8 working hours for the following:

Render advice regarding installation, programming, final adjustment, and testing.

Witness final system test and then certify with an affidavit that the motor controllers are installed in accordance with the contract documents and are operating properly.

Train facility personnel on the operation and maintenance of the motor controllers (minimum of two 1 hour sessions).

Explain available service programs to facility supervisory personnel for their consideration.

* + - * 1. Service Availability: A fully equipped service organization shall be available to service the completed Work.
			1. DELIVERY, STORAGE, AND HANDLING

Retain this article for large and combination, soft-start enclosed controllers.

Retain first paragraph below for enclosed sites with conditioned storage spaces. Retain second paragraph if site conditions require supplemental heating to prevent condensation. If retaining second paragraph, retain first option for controllers that do not have factory-installed space heaters as specified in Part 2; otherwise, retain second option.

* + - * 1. Store soft-start controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect soft-start controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
				2. If stored in areas subject to weather, cover soft-start 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** [**50 W**]<**Insert number**> **per controller**] [**connect factory-installed space heaters to temporary electrical service**].
			1. FIELD CONDITIONS

Soft-start motor controllers are available for use under environmental conditions different than those indicated in this article, which is based on "normal service conditions" of UL 508. However, derating, special modifications, or both, may be required in certain occupancies, such as in boiler rooms. Consult manufacturers for required modifications, derating, or both, to accommodate unusual service conditions. For additional ambient compensation requirements for fuses, circuit breakers, meters, and electronic devices, see the Evaluations for additional guidance.

* + - * 1. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

Ambient Temperature: Not less than 32 deg F and not exceeding 104 deg F, humidity noncondensing.

Altitude: Not exceeding 3300 feet.

To determine whether solar radiation mentioned in first subparagraph below is significant, consult IEEE C37.24.

The effect of solar radiation is insignificant.

<**Insert unusual service condition**>.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. MOTOR CONTROLLER PERFORMANCE REQUIREMENTS
				1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

Retain one of two compliance standards paragraphs below. See the Evaluations for guidance.

* + - * 1. UL Compliance: Fabricate and label enclosed controllers to comply with UL 508.
				2. NEMA Compliance: Fabricate motor controllers to comply with NEMA ICS 2.

Retain "Seismic Performance" paragraph below with "Seismic Qualification Data" paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Soft-start controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor: [**1.5**] [**1.0**].

See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table for requirements to be inserted in subparagraph below.

<**Insert requirements for Component Amplification Factor and Component Response Modification Factor**>.

* + - 1. ENCLOSED SOFT-START MOTOR CONTROLLERS

For capacities and characteristics, see "Motor Controller Schedules" Article in the Evaluations.

Requirements for many of the soft-start motor controller options and accessories are in the "Referenced Standards" Article in the Evaluations, thus these requirements are not restated below. Where the requirements exceed the space normally allowed in the schedule, the additional information is in the Section Text.

* + - * 1. Description: Controllers designed for reduced-voltage start, full-voltage run, and optional soft stop. The controller shall be an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=12771) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Eaton](http://www.specagent.com/Lookup?uid=123457141429).

[Rockwell Automation, Inc](http://www.specagent.com/Lookup?uid=123457141431).

[Square D; Schneider Electric USA](http://www.specagent.com/Lookup?uid=123457141433).

Or equal.

* + - * 1. Standard: Comply with NEMA ICS 2, general purpose, Class A.

Retain first option in "Configuration" paragraph below unless Project conditions require other configurations that apply to all soft-start motor controllers in this Section.

* + - * 1. Configuration: [Standard duty] <Insert configurations>.

At least two SCRs per phase to control the starting and stopping of the motor.

Microprocessor control shall continuously monitor current and proper operation of the SCRs.

See the Evaluations for discussion of bypass contactors.

Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.

Contactor described in "Power Electronics Disconnect Contactor" subparagraph below is considered to be an added cost option by most manufacturers of this equipment.

Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.

Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.

Criteria in "Surge Protection" subparagraph below use test levels of 2 kV L-G and 1 kV L-L. For less-protected locations, consider adding field-installed SPDs specified in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.

* + - * 1. Control Power:

Usual control voltages are 24-V dc and 120-V ac, and the choice is made by manufacturer depending on the motor controller model. Options involving other control voltages and control power sources are available and should be indicated on control schematics on Drawings.

For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

Retain subparagraph below if spare CPT capacity is required. Spare capacity is normally available in 100-VA increments. Consult manufacturers for CPT sizes available for different NEMA and enclosure sizes, because adding spare capacity and an oversized CPT may require using an enlarged enclosure. Indicate capacity in the schedule on Drawings.

Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

* + - * 1. Controller Diagnostics and Protection:

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.

Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.

Retain one of two subparagraphs below for providing motor protection on a controller fault.

Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.

<**Insert items**>.

* + - * 1. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

Starter Status: "Ready," "starting," "stopping," or "run."

Motor current in amperes.

Faults:

Motor overcurrent trip.

Motor thermal overload.

Starter thermal fault.

Low line voltage.

Loss of a phase.

Phases reversed.

Maximum stating time exceeded.

Serial communications error.

Options in "Interface Panel" paragraph below are manufacturer specific. Revise to suit Project.

* + - * 1. Interface Panel: [**Mounted on controller door] [Mounted remotely within 50 feet].[ With plug-in connector and removable.**]

Guarded adjustable set points, not readily accessible.

Motor FLA, adjustable from [**40 to 110**] <**Insert numbers**> percent of the controller's rating.

Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.

Indicate class in the schedule on Drawings; see the Evaluations for discussion of overload trip class. The typical class is 10. The overload class selections in subparagraph below affect the current rating of the controller when considering the number of hourly starts of the motor-driven equipment.

NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.

Adjustable set points, readily accessible[**, password protected**].

Linear acceleration, adjustable from [**1 to 60 s**] <**Insert range in seconds**>.

Maximum start time, adjustable from [**1 to 250 s**] <**Insert range in seconds**>.

Selector switch; select coast to stop or soft stop.

Linear deceleration, adjustable from [**1 to 60 s**] <**Insert range in seconds**>.

* + - * 1. Remote Output Features. All outputs shall be prewired to terminal blocks.

Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10-V dc**] [**4- to 20-mA dc**].

Form C status contacts that change state when controller is running.

Form C alarm contacts that change state when a fault condition occurs.

When inserting items in subparagraph below, coordinate with the controller schedule on Drawings.

<**Insert items**>.

If retaining "Digital Communication Module" paragraph below, indicate where used in the schedule on Drawings.

* + - * 1. Digital Communication Module**: [RS-485 Modbus, RTU protocol, [2] [4]-wire connection to host devices with a compatible port] <Insert protocol**> to transmit the following to the LAN:

Instantaneous root mean square (rms) current each phase, and three-phase average.

Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.

Active Energy (kilowatt-hour): Three-phase total.

Power Factor: [**Each phase and**]three-phase total.

<**Insert value**>.

* + - 1. COMBINATION SOFT-START MOTOR CONTROLLERS

For capacities and characteristics, see "Motor Controller Schedules" Article in the Evaluations.

Requirements for many of the soft-start motor controller options and accessories are in the "Referenced Standards" Article in the Evaluations, thus these requirements are not restated below. Where the requirements exceed the space normally allowed in the schedule, the additional information is in the Section Text.

* + - * 1. Description: Factory-assembled, combination, reduced-voltage soft-start controller with a disconnecting means, SCPD and OCPD, in a single enclosure. The reduced-voltage soft-start controller shall consist of an integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and user interface module, run-bypass contactor, and overload relay(s); suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.

Run-Bypass Contactor: Magnetic contactor in parallel with the SCR of the soft-start controller, bypassing the SCR when full voltage is achieved.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=12772) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

[Eaton](http://www.specagent.com/Lookup?uid=123457141434).

[Rockwell Automation, Inc](http://www.specagent.com/Lookup?uid=123457141436).

[Square D; Schneider Electric USA](http://www.specagent.com/Lookup?uid=123457141438).

Or equal.

* + - * 1. Standard: Comply with NEMA ICS 2, general purpose, Class A.

Retain first option in "Configuration" paragraph below unless Project conditions require other configurations that apply to all soft-start motor controllers in this Section.

* + - * 1. Configuration: [Standard duty] <Insert configurations>.

At least two SCRs per phase to control the starting and stopping of the motor.

Microprocessor control shall continuously monitor current and proper operation of the SCRs.

See the Evaluations for discussion of bypass contactors.

Bypass Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Soft-start controller protective features and deceleration controls shall remain active when this contactor is in the bypass mode.

"Power Electronics Disconnect Contactor" subparagraph below is considered to be an added cost option by most manufacturers of this equipment.

Power Electronics Disconnect Contactor. Where indicated, installed ahead of the power electronics equipment, and shall open automatically when the motor is stopped, or a controller fault is detected, or when an SCR shorts.

Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.

"Surge Protection" subparagraph below uses test levels of 2 kV L-G and 1 kV L-L. For less-protected locations, consider adding field-installed SPDs specified in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

Surge Protection: Comply with NEMA ICS 2 requirements for surge suppression.

* + - * 1. Control Power:

Usual control voltages are 24-V dc and 120-V ac, and the choice is made by manufacturer depending on the motor controller model. Options involving other control voltages and control power sources are available and should be indicated on control schematics on Drawings.

For on-board control power, obtain from line circuit or from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.

Retain subparagraph below if spare CPT capacity is required. Spare capacity is normally available in 100-VA increments. Consult manufacturers for CPT sizes available for different NEMA and enclosure sizes, because adding spare capacity and an oversized CPT may require using an enlarged enclosure. Indicate capacity in the schedule on Drawings.

Spare CPT Capacity: As indicated on Drawings, available in increments of 100 VA, from 100 to 500 VA.

* + - * 1. Controller Diagnostics and Protection:

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.

Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.

Retain one of two subparagraphs below for providing motor protection on a controller fault.

Input isolation contactor that opens when the controller diagnostics detect a faulted soft-start component or when the motor is stopped.

<**Insert items**>.

* + - * 1. Cover mounted-controller status panel with LED lights or alphanumeric display to show the following:

Starter Status: "Ready," "starting," "stopping," or "run."

Motor current in amperes.

Faults:

Motor overcurrent trip.

Motor thermal overload.

Starter thermal fault.

Low line voltage.

Loss of a phase.

Phases reversed.

Maximum stating time exceeded.

Serial communications error.

Options in "Interface Panel" paragraph below are manufacturer specific. Revise to suit Project.

* + - * 1. Interface Panel: [Mounted on controller door] [Mounted remotely within **50 feet**].[ With plug-in connector and removable.]

Guarded adjustable set points, not readily accessible.

Motor FLA, adjustable from [**40 to 110**] <**Insert numbers**> percent of the controller's rating.

Current limitation on starting, adjustable from 200 to 500 percent of FLA, typically set at 300 percent.

Indicate class in the schedule on Drawings; see the Evaluations for discussion of overload trip class. The typical class is 10. The overload class selections in first subparagraph below affect the current rating of the controller when considering the number of hourly starts of the motor-driven equipment.

NEMA ICS 2 overload class. Selections shall include the following tripping classes: Class 5, Class 10, Class 15, Class 20, and Class 30.

Adjustable set points, readily accessible[**, password protected**].

Linear acceleration, adjustable from [**1 to 60 s**] <**Insert range in seconds**>.

Maximum start time, adjustable from [**1 to 250 s**] <**Insert range in seconds**>.

Selector switch; select coast to stop or soft stop.

Linear deceleration, adjustable from [**1 to 60 s**] <**Insert range in seconds**>.

* + - * 1. Remote Output Features: All outputs shall be prewired to terminal blocks.

Analog output for field-selectable assignment of motor operating characteristics; [**0- to 10-V dc**] [**4- to 20-mA dc**].

Form C status contacts that change state when controller is running.

Form C alarm contacts that change state when a fault condition occurs.

When inserting items in subparagraph below, coordinate with the controller schedule on Drawings.

<**Insert items**>.

If retaining "Digital Communication Module" paragraph below, indicate where used in the schedule on Drawings.

* + - * 1. Digital Communication Module: [RS-485 Modbus, RTU protocol, [2] [4]-wire connection to host devices with a compatible port] <Insert protocol> to transmit the following to the LAN:

Instantaneous rms current each phase, and three-phase average.

Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.

Active Energy (kilowatt-hour): Three-phase total.

Power Factor: [**Each phase and**]three-phase total.

<**Insert value**>.

Disconnecting means and OCPDs must be closely coordinated with calculated short-circuit current values at the controller locations because they are directly related to the SCCRs of their combination controllers. Although fusible switches (with appropriate fuses) can provide Type 2 controller protection from very high short-circuit currents, not all circuit breakers or MCPs can. See the Evaluations for explanation of protection types and when they should be considered. The Section Text does not include nonfusible disconnecting means because they are usually not an option with soft-start controllers.

* + - * 1. Fusible Disconnecting Means:

NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate [**Class J**] [**Class L**] [**indicated**] fuses.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

Retain "Auxiliary Contacts" subparagraph below if external control power is used or for remote indication of disconnecting means position.

Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.

MCP disconnecting means in first paragraph below must be used in combination with integral overload relays.

* + - * 1. MCP Disconnecting Means:

UL 489 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.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

Retain one of first two subparagraphs below, or both. Retain first subparagraph if external control power is used or for remote indication of disconnecting means position. Retain second subparagraph for remote indication of tripped condition. If retaining auxiliary and alarm contacts, indicate "a" and "b" contact quantities and NO or NC contact requirements on Drawings.

Auxiliary contacts "a" and "b" arranged to activate with MCP handle.

[**NC**] [**NO**] alarm contact that operates only when MCP has tripped.

Subparagraph below is an optional, added-cost feature.

Current-limiting module to increase controller SCCR (withstand) to 100 kA.

* + - * 1. MCCB Disconnecting Means:

UL 489 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.

Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

Retain one or both subparagraphs below. Retain first subparagraph if external control power is used or for remote indication of disconnecting means position. Retain second subparagraph for remote indication of tripped condition. If retaining auxiliary and alarm contacts, indicate "a" and "b" contact quantities and NO or NC contact requirements on Drawings.

Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

[**NC**] [**NO**] alarm contact that operates only when MCCB has tripped.

* + - * 1. Molded-Case Switch Disconnecting Means:

UL 489 and NEMA AB 3, with in-line fuse block for Class J or Class 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.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

Retain one or both subparagraphs below. Retain first subparagraph if external control power is used or for remote indication of disconnecting means position. Retain second subparagraph for remote indication of tripped condition. If retaining auxiliary and alarm contacts, indicate "a" and "b" contact quantities and NO or NC contact requirements on Drawings.

Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.

[**NC**] [**NO**] alarm contact that operates only when molded-case switch has tripped.

* + - 1. BYPASS MOTOR CONTROLLER

Retain this article to specify a combination full-voltage electromagnetic motor controller as the bypass of the enclosed or combination soft-start controller. This controller type is also covered in Section 262913.03 "Magnetic Motor Controllers."

When retaining this article, indicate the connection of the bypass motor controller to the main controller in a schematic diagram on Drawings, and schedule the controller attributes in a controller schedule on Drawings. See "Bypass Motor Controller" Article in the Evaluations for additional discussion on use of bypass motor controllers.

* + - * 1. Description: Factory-assembled, combination, full-voltage electromagnetic motor controller with a disconnecting means, SCPD and OCPD, in a single enclosure. Connected as a bypass controller, operating manually, with NORMAL/BYPASS selector switch.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=12769) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Eaton](http://www.specagent.com/Lookup?uid=123457141424).

[Rockwell Automation, Inc](http://www.specagent.com/Lookup?uid=123457141426).

[Square D; Schneider Electric USA](http://www.specagent.com/Lookup?uid=123457141428).

Or equal.

* + - * 1. Standard:

Comply with NEMA ICS 2, general purpose, Class A.

Fabricate and label the bypass motor controllers to comply with UL 60947-4-1.

In "Configuration" paragraph below, retain configurations for this Project. If retaining more than one, indicate where used in the schedule on Drawings.

* + - * 1. Configuration: Across-the-line start, electrically held.
				2. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

Operating Voltage: Manufacturer's standard unless otherwise indicated.

Retain "Control Power" paragraph below if Project includes controllers with on-board control power supply. For separate external power sources, annotate the motor controller schedule and indicate the control power source in the schedule on Drawings.

* + - * 1. Control Power: [**24**] [**120**]-V ac; obtained from integral CPT, with primary and secondary fuses, and with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

Retain subparagraph below if spare CPT capacity is required. Spare capacity is normally available in 100-VA increments. Consult manufacturers for CPT sizes available for different NEMA and enclosure sizes, because adding spare capacity and an oversized CPT may require using an enlarged enclosure. Indicate capacity in the schedule on Drawings.

Spare CPT Capacity: As indicated on Drawings, [**50**] [**100**] [**200**] <**Insert number**> VA.

* + - * 1. Overload Relays:

See "Motor Overload Protection" Article in the Evaluations for additional guidance.

Thermal-Overload Relays:

Inverse-time-current characteristic.

[**Class 10**] [**Class 20**] [**Class 30**] tripping characteristic.

Heaters in each phase shall be matched to nameplate FLA of actual protected motor and with appropriate adjustment for duty cycle.

Retain one of first two subparagraphs below, or both, only if applicable. See "Motor Overload Protection" Article in the Evaluations for guidance and warnings.

Ambient compensated.

Automatic resetting.

Solid-State Overload Relays:

Switch or dial selectable for motor running overload protection.

Sensors in each phase.

Retain one or more tripping characteristics in first subparagraph below. If retaining more than one, indicate where each type is required in the schedule on Drawings.

[**Class 10**] [**Class 20**] [**Class 30**] [**Class 10/20 selectable**] tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

If retaining "Class II Ground-Fault Protection" paragraph below, indicate where used in the schedule on Drawings.

* + - * 1. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

If retaining "Digital Communication Module" paragraph below, indicate where used in the schedule on Drawings.

* + - * 1. Digital Communication Module: [RS-485 Modbus, RTU protocol, [2] [4]-wire connection to host devices with a compatible port] <Insert protocol> to transmit the following to the LAN:

Instantaneous rms current each phase, and three-phase average.

Voltage: L-L for each phase, L-L three-phase average, L-N each phase, and L-N three-phase average - rms.

Active Energy (kilowatt-hour): Three-phase total.

Power Factor: [**Each phase and**]three-phase total.

<**Insert value**>.

Retain "Fusible Disconnecting Means" paragraph below to meet SCCR requirements. Typical SCCR value of this combination controller is 100 kA.

* + - * 1. Fusible Disconnecting Means:

NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

Nonfusible switches have no inherent SCCR or interrupting current ratings and so must be used in series with upstream fuses or specific types and ratings of circuit breakers. See "Bypass Motor Controller" Article in the Evaluations.

* + - * 1. Nonfusible Disconnecting Means:

NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

MCP disconnecting means in first paragraph below must be used in combination with integral overload relays.

Retain "MCP Disconnecting Means" paragraph below to meet SCCR requirements. Typical SCCR values for this combination controller are 65 or 100 kA, depending on voltage and MCP selection.

* + - * 1. MCP Disconnecting Means:

UL 489 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.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

Retain "MCCB Disconnecting Means" paragraph below to meet SCCR requirements. Typical SCCR values for this combination controller are 65 or 100 kA, depending on voltage and MCCB selection.

* + - * 1. MCCB Disconnecting Means:

UL 489 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.

Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

* + - 1. ENCLOSURES

The enclosure type for each controller should be indicated in the controller schedule on Drawings. See the Evaluations for guidance on selecting the enclosure type.

* + - * 1. Comply with NEMA 250, Type designations as indicated on Drawings, to comply with environmental conditions at installed location.
				2. Construction of the enclosures shall comply with NEMA ICS 6.
				3. Controllers in hazardous (classified) locations shall comply with UL 1203.
			1. ACCESSORIES

Accessories listed in this article are limited in application by controller and enclosure types. Indicate requirements for and quantities of accessories in schedule on Drawings. See "Accessories" Article in the Evaluations for additional guidance.

* + - * 1. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

Push Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy-duty or oiltight where indicated in the controller schedule.

Push Buttons: As indicated in the controller schedule.

Pilot Lights: As indicated in the controller schedule.

Elapsed Time Meters: Heavy duty with digital readout in hours[**; nonresettable**] [**; resettable**].

Retain subparagraph below if metering (for amperes, voltage, frequency, watts, power factor, and so on) is required for controllers. Indicate in the schedule on Drawings where and which types of metering and selector switches are required. Normally, metering is limited to enclosure Types 1 and 12; consult manufacturers on availability of meters in other types of enclosures. Note that metered data can be obtained through the communication output of the solid-state overload relays.

Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy. Where indicated, provide selector switches with an off position.

* + - * 1. Breather assemblies, to maintain interior pressure and release condensation in [**Type 4**] [**Type 4X**] [**Type 7**] [**Type 9**] <**Insert type**> enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
				2. Space heaters, with NC 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.
				3. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

When inserting accessories, update the appropriate controller schedule on Drawings.

* + - * 1. **<Insert accessories**>.
			1. IDENTIFICATION

Coordinate this article with Drawings and Section 260553 "Identification for Electrical Systems."

* + - * 1. Arc-Flash Warning Labels:

Retain first subparagraph below if the OCPD arc-flash study is included in the work of Contractor. Retain second subparagraph below if the OCPD arc-flash study results are indicated on Drawings.

Produce a 3-1/2-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

Location designation.

Nominal voltage.

Flash protection boundary.

Hazard risk category.

Incident energy.

Working distance.

Engineering report number, revision number, and issue date.

Labels shall be machine printed, with no field-applied markings.

1. EXECUTION
	* + 1. EXAMINATION
				1. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.
			2. INSTALLATION
				1. Comply with NECA 1.

Retain "Floor-Mounted Controllers" paragraph below to require equipment to be installed on cast-in-place concrete equipment bases.

Retain first paragraph below for interior installations. Indicate vibration isolation and seismic control device type and minimum deflection in supported equipment schedule on Drawings.

* + - * 1. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
				2. Control Wiring: Separate control wiring from power wiring. Where unavoidable, use twisted pair cabling or shielded cables for control wiring.
				3. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
				4. Setting of Overload Relays: Select and set overloads on the basis of FLA rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for high-torque, high-efficiency, and so on motors.
			1. IDENTIFICATION
				1. Identify system components, wiring, cabling, and terminals.
			2. FIELD QUALITY CONTROL

Retain one of first four paragraphs below. Retain first "Testing Agency" paragraph below if Owner will hire an independent testing agency.

* + - * 1. Testing Agency: Director’s Representative will engage a qualified testing agency to perform tests and inspections.

Retain "Testing Agency" paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

Retain "Manufacturer's Field Service" paragraph below to require a factory-authorized service representative to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a Company Service Advisor to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform tests and inspections" paragraph below to require Contractor to perform tests and inspections and retain option to require Contractor to arrange for the assistance of a factory-authorized service agent.

* + - * 1. Perform tests and inspections**[ with the assistance of a Company Service Advisor**].

Retain test requirements below with any combination of paragraphs above. The following tests and inspections are derived from the NETA ATS.

* + - * 1. Tests and Inspections:

NFPA 70B reference in first subparagraph below contains requirements for qualifications of test operators and test equipment.

Comply with provisions of NFPA 70B, Chapter "Testing and Test Methods."

Visual and Mechanical Inspection:

Compare equipment nameplate data with Drawings and the Specifications.

Inspect physical and mechanical condition.

Inspect anchorage, alignment, and grounding.

Verify that the unit is clean.

Ensure that vent path openings are free from debris and that heat-transfer surfaces are clean.

Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.

Inspect Contactors:

Verify mechanical operation.

Verify that contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

Motor-Running Protection:

Verify that motor FLA is at, or under, the controller current rating.

Verify that overload element setting is correct for its application.

Apply minimum- and maximum-speed set points. Verify that set points are within limitations of the load coupled to the motor.

If motor-running protection is provided by fuses, verify correct fuse rating.

Inspect bolted electrical connections for high resistance using one of the following two methods:

Use a low-resistance ohmmeter. Compare bolted-connection-resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

Electrical Tests:

[**For the contactor and circuit breaker, perform**] [**Perform**]insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS, Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than this table or manufacturer's written instructions shall be investigated and corrected.

Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.

Test motor protection devices according to manufacturer's published data.

Test circuit breakers as follows:

Operate the circuit breaker to ensure smooth operation.

For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.

Test the electronic motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

Test the following parameters according to NETA relay calibration procedures, or as recommended by manufacturer:

ANSI No. 49R, Overtemperature Protection:

Determine time delay at 300 percent of setting.

Determine a second point on the operating curve.

The pickup determination in first subparagraph below is normally considered an optional field test.

Determine pickup.

ANSI No. 47, Input Phase Loss and Reversed Phases Protection:

Determine positive sequence voltage to close the NO contact.

Determine positive sequence voltage to open the NC contact (undervoltage trip).

Verify negative sequence trip.

Determine time delay to close the NO contact with sudden application of 120 percent of pickup.

Determine time delay to close the NC contact on removal of voltage when previously set to rated system voltage.

ANSI No. 81, Overfrequency Protection:

Verify frequency set points.

Determine time delay.

Determine undervoltage cutoff.

Fault Alarm Outputs: Verify that each relay contact performs its intended function in the control scheme including breaker trip tests, close inhibit tests, lockout tests, and alarm functions.

Perform operational tests by initiating control devices.

Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.

Comply with recommendations of NFPA 70B, Chapter "Testing and Test Methods," Article "Infrared Inspection."

After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.

Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.

Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:

Description of equipment to be tested.

Discrepancies.

Temperature difference between the area of concern and the reference area.

Probable cause of temperature difference.

Areas inspected. Identify inaccessible and unobservable areas and equipment.

Identify load conditions at time of inspection.

Provide photographs and thermograms of the deficient area.

Recommended action.

Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.

Act on inspection results, recommended action, and considering recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Director’s Representative operations permit. Retest until deficiencies are corrected.

* + - * 1. Motor controllers will be considered defective if they do not pass tests and inspections.
				2. Prepare test and inspection reports.
			1. SYSTEM FUNCTION TESTS
				1. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.

Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.

Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.

Verify the correct operation of sensing devices, alarms, and indicating devices.

* + - * 1. Motor controllers will be considered defective if they do not pass the system function tests and inspections.
				2. Prepare test and inspection reports.
			1. DEMONSTRATION
				1. [**Engage a** Company Service Advisor **to train**] [**Train**] Director’s Representative maintenance personnel to adjust, operate, and maintain motor controllers.

END OF SECTION 262913.06