SECTION 262913.03 - MANUAL AND MAGNETIC 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:

Manual motor controllers.

Enclosed full-voltage magnetic motor controllers.

Combination full-voltage magnetic motor controllers.

Enclosed reduced-voltage magnetic motor controllers.

Combination reduced-voltage magnetic motor controllers.

Multispeed magnetic motor controllers.

Combination multispeed magnetic motor controllers.

Enclosures.

Accessories.

Identification.

* + - 1. DEFINITIONS

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

* + - * 1. CPT: Control power transformer.
				2. MCCB: Molded-case circuit breaker.
				3. MCP: Motor circuit protector.
				4. NC: Normally closed.
				5. OCPD: Overcurrent protective device.
				6. SCCR: Short-circuit current rating.
				7. SCPD: Short-circuit protective device.
			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 magnetic 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 overcurrent protective devices and auxiliary components.

* + - * 1. Product Schedule: List the following for each enclosed controller:

Each installed magnetic controller type.

NRTL listing.

Factory-installed accessories.

Nameplate legends.

SCCR of integrated unit.

For each combination magnetic 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 short-circuit current (withstand) rating of SCPD 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 magnetic 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.

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 magnetic controllers to include in operation and maintenance manuals.

Routine maintenance requirements for magnetic controllers and installed components.

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

Manufacturer's written instructions for setting field-adjustable overload relays.

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 full-load currents.

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 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’s Representative 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 multispeed and the adjustable speed 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 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 controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
				2. If stored in areas subject to weather, cover 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

Magnetic motor controllers are available for use under environmental conditions different from those indicated in four subparagraphs below, which are based on "normal service conditions" of UL 60947-4-1. 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. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.

Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

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

The effect of solar radiation is not significant.

<**Insert unusual service condition**>.

1. PRODUCTS

The requirements for many of the magnetic motor controller options and accessories are in the standards cited in the Section Text, thus these requirements are not restated in the Section Text. Where the requirements exceed the space normally allowed in the schedule, the additional information is in the Section Text. See "Referenced Standards" Article in the Evaluations for a complete list of standards.

For capacities and characteristics, see the schedule on Drawings. An example schedule is located at the end of the Evaluations.

* + - 1. 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.
				2. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
				3. NEMA Compliance: Fabricate motor controllers to comply with 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: Magnetic controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

Retain 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 controller 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. MANUAL MOTOR CONTROLLERS

Retain one or more types of manual motor controllers. Coordinate with Drawings.

Motor-starting switches (MSS) in the paragraph below do not have integral overload relays. See "Motor-starting switches" paragraph under "Manual Motor Controllers" Article in the Evaluations for additional guidance on their use.

* + - * 1. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=2157) 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=123457141377).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141380).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141376).

Or equal.

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

Configuration: [**Nonreversing**] [**Reversing**] [**Two speed**].

First option in first subparagraph below is available only with NEMA 250, Type 1 enclosures but not from all listed manufacturers. Consult manufacturers for availability of flush enclosures and finishes for flush cover plates because each manufacturer offers different types.

[**Flush**] [**Surface**] mounting.

Not all manufacturers offer a green pilot light; pilot lights are not available in hazardous and some cast-type enclosures.

[**Red**] [**Green**] pilot light.

Additional Nameplates: [**FORWARD and REVERSE for reversing switches**] [**HIGH and LOW for two-speed switches**] <**Insert special markings**>.

One- and two-pole fractional horsepower manual controllers in the paragraph below are suitable for use with single-phase ac motors up to 1 hp. See "Fractional horsepower manual motor controllers" paragraph in the "Manual Motor Controllers" Article in the Evaluations for additional guidance on their use.

* + - * 1. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=2158) 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=123457141383).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141386).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141382).

Or equal.

Configuration: [**Nonreversing**] [**Two speed**].

Retain one of two "Overload Relays" subparagraphs below. See "Motor Overload Protection" Article in the Evaluations for additional guidance on retaining options in first subparagraph below. Although Class 10 seems to be "standard" for this equipment, some manufacturers may offer others. Retain first option below unless another class is required and available.

Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, [**Class 10**] <**Insert class**> tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button[**; bimetallic type**] [**; melting alloy type**].

Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.

Retain "Pilot Light" subparagraph below to be the default in the schedule on Drawings. Not all manufacturers offer a pilot light, and pilot lights are not available in hazardous and some cast-type enclosures.

Pilot Light: [**Red**] <**Insert color**>.

One-, two-, and three-pole integral horsepower manual controllers in the paragraph below are suitable for use with single- and three-phase ac motors up to 10 hp at 480-V ac. See "Integral horsepower manual motor controllers" paragraph in the "Manual Motor Controllers" Article in the Evaluations for additional guidance on their use.

* + - * 1. Integral Horsepower Manual Controllers (IHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=2159) 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=123457141388).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141391).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141387).

Or equal.

Configuration: [**Nonreversing**] [**Two speed**].

Retain one of two "Overload Relays" subparagraphs below. See "Motor Overload Protection" Article in the Evaluations for additional guidance on retaining options in first subparagraph below. Although Class 10 seems to be "standard" for this equipment, some manufacturers may offer others. Retain first option below unless another class is required and available.

Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, [**Class 10**] <**Insert class**> tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button[**; bimetallic type**] [**; melting alloy type**].

Overload Relays: NEMA ICS 2, bimetallic class as scheduled on Drawings.

* + - 1. ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

For capacities and characteristics, see the schedule in the Evaluations.

* + - * 1. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=12768) 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=123457141407).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141411).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141410).

Or equal.

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

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

* + - * 1. Configuration: [**Nonreversing**] <**Insert configuration**>.
				2. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

Operating Voltage: Manufacturer's standard, unless 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 show the control power source in the schedule on Drawings.

* + - * 1. Control Power:

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 first 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 full-load current of actual protected motor and with appropriate adjustment for duty cycle.

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

Ambient compensated.

Automatic resetting.

Solid-State Overload Relay:

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 subparagraph below, indicate where Class II ground-fault protection is used in the schedule on Drawings.

Class II ground-fault protection shall 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 paragraph below, indicate where digital communication module is used in the schedule on Drawings. Coordinate with Section 260913 "Electrical Power Monitoring and Control."

* + - * 1. Digital communication module, using [**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 3-phase average.

Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.

Active Energy (kWh): 3-phase total.

Power Factor: [**Each phase and**]3-phase total.

<**Insert value**>.

* + - 1. COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

See "Combination Motor Controllers" Article in the Evaluations for considerations in the selection of components of combination motor controllers. Indicate applicable disconnecting means in the schedule on Drawings.

For capacities and characteristics, see the schedule in the Evaluations.

* + - * 1. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

* + - * 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=123457141412).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141416).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141415).

Or equal.

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

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

* + - * 1. Configuration: [**Nonreversing**] <**Insert configuration**>.
				2. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

Operating Voltage: Manufacturer's standard, unless 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 show the control power source in the schedule on Drawings.

* + - * 1. Control Power:

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: [**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 full-load current of actual protected motor and with appropriate adjustment for duty cycle.

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

Ambient compensated.

Automatic resetting.

Solid-State Overload Relay:

Switch or dial selectable for motor-running overload protection.

Sensors in each phase.

Retain one or more tripping characteristics in 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.

Retain first paragraph below for Class II ground-fault protection, and indicate where used in the schedule on Drawings.

* + - * 1. Class II ground-fault protection shall 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.

Retain first paragraph below for digital communication module, and indicate where used in the schedule on Drawings. Coordinate with Section 260913 "Electrical Power Monitoring and Control."

* + - * 1. Digital communication module, using [**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 3-phase average.

Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.

Active Energy (kWh): 3-phase total.

Power Factor: [**Each phase and**]3-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 short-circuit or interrupting current ratings and so must be used in series with upstream fuses or specific types and ratings of circuit breakers.

* + - * 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 kA 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 kA or 100 kA depending on voltage and MCCP 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. ENCLOSED REDUCED-VOLTAGE MAGNETIC MOTOR CONTROLLERS

For capacities and characteristics, see the schedule on Drawings.

* + - * 1. Description: Electrically held; closed-transition; adjustable time delay on transition, 600-V ac or less.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=12770) 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=123457141417).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141421).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141420).

Or equal.

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

Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.

Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.

Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

* + - * 1. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

Operating Voltage: Manufacturer's standard, unless indicated.

Retain "Control Power" paragraph below if Project includes controllers with on-board control power supply. For external power sources, annotate the schedule on Drawings.

* + - * 1. Control Power: [**24**] [**120**]-V ac; obtained from integral CPT, with primary and secondary fuses, 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: [**50**] [**100**] [**200**] <**Insert number**> VA.

* + - * 1. Overload Relays:

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

Thermal Overload Relays: [**Melting alloy type**] [**Bimetallic type**].

Inverse-time-current characteristic.

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

Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

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

Ambient compensated.

Automatic resetting.

Solid-State Overload Relay:

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 Full-Voltage Magnetic Motor Controllers 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" subparagraph below, indicate where used in the schedule on Drawings.

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 3-phase average.

Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.

Active Energy (kWh): 3-phase total.

Power Factor: [**Each phase and**]3-phase total.

<**Insert value**>.

See "Combination Motor Controllers" Article in the Evaluations for considerations in the selection of components of combination motor controllers. Indicate applicable disconnecting means in the schedule on Drawings.

* + - 1. COMBINATION REDUCED-VOLTAGE MOTOR CONTROLLERS

For capacities and characteristics, see the schedule on Drawings.

* + - * 1. Description: Factory-assembled, combination reduced-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, and SCPD and OCPD, in a single enclosure.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=2163) 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=123457141393).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141396).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141392).

Or equal.

* + - * 1. Configuration:

Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.

Part-Winding Controller: Separate START and RUN contactors, field-selectable for 1/2- or 2/3-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.

Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

* + - * 1. Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors when indicated**].

Operating Voltage: Manufacturer's standard, unless indicated.

Retain "Control Power" paragraph below if Project includes controllers with on-board control power supply. For external power sources, annotate the schedule on Drawings.

* + - * 1. Control Power: [**24**] [**120**]-V ac; obtained from integral CPT, with primary and secondary fuses, 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: [**50**] [**100**] [**200**] <**Insert number**> VA.

* + - * 1. Overload Relays:

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

Thermal Overload Relays: [**Melting alloy type**] [**Bimetallic type**].

Inverse-time-current characteristic.

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

Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

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

Ambient compensated.

Automatic resetting.

Solid-State Overload Relay:

Switch or dial selectable for motor-running overload protection.

Sensors in each phase.

Retain one or more tripping characteristics in subparagraph below. If retaining more than one, indicate where each type is required in the Full-Voltage Magnetic Motor Controllers 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 3-phase average.

Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.

Active Energy (kWh): 3-phase total.

Power Factor: [**Each phase and**]3-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 short-circuit or interrupting current ratings and so must be used in series with upstream fuses or specific types and ratings of circuit breakers.

* + - * 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 kA 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 kA or 100 kA depending on voltage and MCCP 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. MULTISPEED MAGNETIC CONTROLLERS

For capacities and characteristics, see the schedule on Drawings.

* + - * 1. Description: Two speed, full voltage, across the line, electrically held.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=2170) 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=123457141398).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141401).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141397).

Or equal.

Show controller pole quantities on Drawings. See "Multispeed Magnetic Motor Controllers" Article in the Evaluations for selection considerations. The Section Text includes only two-speed controllers; however, most manufacturers catalog controllers offering more than two speeds. Multispeed motor controllers supporting more than two speeds may be added to meet Project requirements.

Verify availability and unique characteristics with manufacturers. Show on Drawings those features and accessories that apply to each controller.

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

When retaining "multispeed" option in first subparagraph below, indicate whether the multispeed motor is a consequent pole or two-winding type.

Configuration: Nonreversing[**, multispeed**].

Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

Operating Voltage: Manufacturer's standard, unless indicated.

Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

Retain "Control Power" subparagraph below if Project includes controllers with on-board control power supply. For external power sources, annotate the schedule on Drawings.

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

Retain first 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: [**50**] [**100**] [**200**] <**Insert number**> VA.

Retain one or both of first two subparagraphs below. If retaining both, indicate on Drawings where each type is required. Compelling and accelerating relays cannot be specified together for the same controller. Compelling, accelerating, and decelerating relays can be used for all multispeed controllers; antiplugging relays are used only for reversing multispeed controllers.

Compelling relays shall ensure that motor will start only at low speed.

Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.

Decelerating timer relays shall ensure automatically timed deceleration through each speed.

Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.

* + - * 1. Overload Relays:

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

Thermal Overload Relays: [**Melting alloy type**] [**Bimetallic type**].

Inverse-time-current characteristic.

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

Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

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

Ambient compensated.

Automatic resetting.

Solid-State Overload Relay:

Switch or dial selectable for motor-running overload protection.

Sensors in each phase.

Retain one or more tripping characteristics in subparagraph below. If retaining more than one, indicate where each type is required in the Full-Voltage Magnetic Motor Controllers 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 first paragraph below, indicate where Class II ground-fault protection is used in the schedule on Drawings.

* + - * 1. Class II ground-fault protection shall 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 paragraph below, indicate where digital communication module is used in the schedule on Drawings.

* + - * 1. Digital communication module, using [**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 3-phase average.

Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.

Active Energy (kWh): 3-phase total.

Power Factor: [**Each phase and**]3-phase total.

<**Insert value**>.

* + - 1. Combination Multispeed Magnetic Motor Controller

See "Combination Motor Controllers" Article in the Evaluations for considerations in the selection of components of combination motor controllers. Indicate applicable disconnecting means in the schedule on Drawings.

* + - * 1. Description: Factory-assembled, combination of multispeed magnetic motor controller, consisting of the controller, indicated disconnecting means, and SCPD and OCPD, in a single enclosure.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=2172) 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=123457141403).

[Schneider Electric USA (Square D)](http://www.specagent.com/Lookup?uid=123457141406).

[Siemens Industry, Inc., Energy Management Division](http://www.specagent.com/Lookup?uid=123457141402).

Or equal.

Show controller pole quantities on Drawings. See "Multispeed Magnetic Motor Controllers" Article in the Evaluations for selection considerations. The Section Text includes only two-speed controllers; however, most manufacturers catalog controllers offering more than two speeds. Multispeed motor controllers supporting more than two speeds may be added to meet Project requirements.

Verify availability and unique characteristics with manufacturers. Show on Drawings those features and accessories that apply to each controller.

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

Configuration: [**Nonreversing**] [**Reversing**]; [**consequent pole**] [**two-winding**].

Contactor Coils: Pressure-encapsulated type[**with coil transient suppressors**].

Operating Voltage: Manufacturer's standard, unless indicated.

Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

Retain "Control Power" subparagraph below if Project includes controllers with on-board control power supply. For external power sources, annotate the schedule on Drawings.

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

Retain first 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: [**50**] [**100**] [**200**] <**Insert number**> VA.

Retain one or both of first two subparagraphs below. If retaining both, indicate on Drawings where each type is required. Compelling and accelerating relays cannot be specified together for the same controller. Compelling, accelerating, and decelerating relays can be used for all multispeed controllers; antiplugging relays are used only for reversing multispeed controllers.

Compelling relays shall ensure that motor will start only at low speed.

Accelerating timer relays shall ensure properly timed acceleration through speeds lower than that selected.

Decelerating timer relays shall ensure automatically timed deceleration through each speed.

Antiplugging timer relays shall ensure a time delay when transferring from FORWARD to REVERSE and back.

* + - * 1. Overload Relays:

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

Thermal Overload Relays: [**Melting alloy type**] [**Bimetallic type**].

Inverse-time-current characteristic.

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

Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

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

Ambient compensated.

Automatic resetting.

Solid-State Overload Relay:

Switch or dial selectable for motor-running overload protection.

Sensors in each phase.

Retain one or more tripping characteristics in subparagraph below. If retaining more than one, indicate where each type is required in the Full-Voltage Magnetic Motor Controllers 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 first paragraph below, indicate where Class II ground-fault protection is used in the schedule on Drawings.

* + - * 1. Class II ground-fault protection shall 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 first paragraph below, indicate where digital communication module is used in the schedule on Drawings.

* + - * 1. Digital communication module, using [**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 3-phase average.

Voltage: L-L for each phase, L-L 3-phase average, L-N each phase and L-N 3-phase average - rms.

Active Energy (kWh): 3-phase total.

Power Factor: [**Each phase and**]3-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 short-circuit or interrupting current ratings and so must be used in series with upstream fuses or specific types and ratings of circuit breakers. 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 kA 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 "MCCP Disconnecting Means" paragraph below to meet SCCR requirements. Typical SCCR values for this combination controller are 65 kA or 100 kA depending on voltage and MCCP 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 on 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, complying with environmental conditions at installed location.
				2. The 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 have limited applications to manual controllers and are also limited in application by controller and enclosure types. Indicate requirements for and quantities of accessories in the 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 oil-tight 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 two percent accuracy. Where indicated, provide selector switches with an off position.

Features in first paragraph below are available in individual relays or combined into a single multipurpose relay. Consult manufacturers for availability. Consider specifying phase-failure relays for single-phasing protection in fusible-switch combination controllers if solid-state overload relays are not specified.

* + - * 1. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.

Phase-failure.

Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.

Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

<**Insert description**>

* + - * 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. Controller Nameplates: [**Baked enamel signs**] [**Metal backed butyrate signs**] [**Laminated acrylic or melamine plastic signs**].
				2. Arc-Flash Warning Labels:

Retain first "Comply" subparagraph below if the overcurrent protective device arc-flash study is included in the work of Contractor. Retain second "Comply" subparagraph below if the overcurrent protective device arc-flash study results are indicated on Drawings.

Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

Produce a 3.5-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.
				2. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall.

Retain first paragraph below to require equipment to be installed on cast-in-place concrete equipment bases.

* + - * 1. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s).

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. 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.
				3. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.
			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 inspection and retain the optional text 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:

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

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

Visual and Mechanical Inspection:

Compare equipment nameplate data with drawings and specifications.

Inspect physical and mechanical condition.

Inspect anchorage, alignment, and grounding.

Verify the unit is clean.

Inspect contactors:

Verify mechanical operation.

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

Motor-Running Protection:

Verify overload element rating is correct for its application.

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

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

Use a low-resistance ohmmeter. Compare bolted connection resistance values with 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 those of this table or manufacturer's recommendations 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.

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

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.

Load conditions at time of inspection.

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

* + - * 1. Motor controller will be considered defective if it does 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 controller will be considered defective if it does 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's maintenance personnel to adjust, operate, and maintain switchgear.

END OF SECTION 262913.03