SECTION 260221- MOTORS AND MOTOR CONTROLLERS

See information at end of section.

1. GENERAL

Omit article below for combined single contract project.

* + - 1. PRODUCTS FURNISHED BUT NOT INSTALLED
         1. Deliver the following items to the Electrical Work Contractor for installation and connection to power wiring:

Motor controllers including 2 copies of approved wiring diagrams.

* + - 1. RELATED WORK SPECIFIED ELSEWHERE
         1. Wiring for Motors and Motor Controllers: Section 260523.
      2. REFERENCES
         1. NEMA MG-1 - Motors and Generators.
         2. NEMA ICS - General Standards for Industrial Control and Systems.
         3. UL508 - Electric Industrial Control Equipment.
         4. IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
      3. 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. Waiver of Submittals: The “Waiver of Certain Submittal Requirements” in Section 013300 does not apply to this Section.
         5. Submittal Package: Submit the product data, and quality control submittals specified below at the same time as a package.
         6. Product Data:

Motor Controllers: Catalog sheets, specifications, and installation instructions. Submit product data for motor controllers simultaneously with product data required for motors.

Identify each controller for use with corresponding motor.

Describe overload devices being supplied with each motor controller (include equipment manufacturer’s recommendations).

Enumerate and describe all accessories being supplied with each motor controller.

All Motors:

Catalog sheets, specifications and installation instructions.

Data proving that voltage rating of each motor is in accordance with specified NEMA standard motor voltage.

Data proving that the service factor and temperature rise for the motor’s insulation system conforms to NEMA standards for each motor’s specific application.

Data proving that the motor efficiency rating conforms to NEMA testing and marking standards MG1-12.54 and 12.55.

Additional Data for Motors Controlled by Solid State or Adjustable Speed Motor Controllers:

Data proving that the motor has been designed for use with associated controller.

Include subparagraph below when applicable. Coordinate with 2.04 a.2.h.

Data proving that the motor has been designed for use with DC injection braking.

Additional Data for Motors 50 HP and Larger: Certified report of manufacturer’s routine tests for each motor (NEMA MG 1-12.54).

* + - * 1. Quality Control Submittals:

Include subparagraph below for adjustable speed controllers.

Harmonic analysis report.

Include subparagraph below for solid state and adjustable speed controllers.

Company Field Advisor Data: Include:

Name, business address and telephone number of Company Field Advisor secured for the required services.

Certified statement from the Company listing the qualifications of the Company Field Advisor.

Services and each product for which authorization is given by the Company listed specifically for this project.

* + - * 1. Contract Closeout Submittals:

Include 2 subparagraphs below for solid state and adjustable speed controllers.

System acceptance test report.

Certificate: Affidavit, signed by the Company Field Advisor and notarized, certifying that the system meets the contract requirements and is operating properly.

Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director’s Representative.

Include article below for solid state and adjustable speed controllers.

* + - 1. QUALITY ASSURANCE
         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 (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. Harmonic Analysis:

The adjustable speed motor controller manufacturer shall perform a harmonic current magnitude and voltage distortion analysis and provide certified calculations specific to this installation, showing that the total harmonic distortion caused by the adjustable speed motor controller will be below the specified level. The analysis shall be accordance with IEEE 519.

Use subparagraph below for new electrical system.

The results shall be based on a computer aided/modeled circuit simulation of the actual system, based upon the materials and equipment proposed to be furnished and installed.

Use subparagraph below for existing electrical system.

The results shall be based on a computer aided/model circuit from the controller to the distribution transformer supplying the controller, based upon the materials and equipment proposed to be furnished and installed, and associated portions of the existing electrical system.

Basic parameters relative to the existing system are specified herein. Additional information deemed necessary by the controller manufacturer to provide a certified harmonic analysis report shall be obtained by a field investigation of the existing system, at no additional cost to the State.

Edit number of hours to suit.

* + - * 1. Company Field Advisor: Secure the services of a Company Field Advisor from the Company providing the solid state controllers 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. PRODUCTS
   * + 1. MOTORS
          1. Classification:

Classification According to Application: Comply with NEMA standards for general-purpose alternating-current squirrel-cage induction motors, except:

If a motor is other than a general-purpose dripproof motor, specify the nema motor type in the equipment section where the motor is required. Refer to NEMA mg1-1.05, 1.09 and 1.13 for definition of motor classifications.

Furnish NEMA definite-purpose or special-purpose motors when required to suit the application.

Furnish NEMA type other than squirrel-cage construction when required to suit the application.

Classification According to Environmental Protection and Methods of Cooling: Comply with NEMA requirements for a dripproof machine unless otherwise specified or indicated on the drawings, or required to suit the application.

* + - * 1. Efficiency: Motors shall be stamped with a NEMA nominal efficiency rating in accordance with NEMA testing and marking standards MG1-12.54 and 12.55.

Nominal full-load three phase motor efficiency:

|  |  |  |  |
| --- | --- | --- | --- |
| **OPEN MOTORS** | | | |
| **RPM** | **1200** | **1800** | **3600** |
| **HP** |  |  |  |
| 1.0 | 80.0 | 82.5 |  |
| 1.5 | 84.0 | 84.0 | 82.5 |
| 2.0 | 86.5 | 84.0 | 84.0 |
| 3.0 | 86.5 | 86.5 | 84.0 |
| 5.0 | 88.5 | 87.5 | 85.5 |
| 7.5 | 89.5 | 88.5 | 87.5 |
| 10 | 90.2 | 89.5 | 88.5 |
| 15 | 91.0 | 90.2 | 89.5 |
| 20 | 90.2 | 91.0 | 90.2 |
| 25 | 91.7 | 92.4 | 91.0 |
| 30 | 92.4 | 93.0 | 92.4 |
| 40 | 93.0 | 93.0 | 92.4 |
| 50 | 92.4 | 94.1 | 92.4 |
| 60 | 93.0 | 93.6 | 93.0 |
| 75 | 93.6 | 94.1 | 93.6 |
| 100 | 93.6 | 94.1 | 93.6 |
| 125 | 94.1 | 94.1 | 93.6 |
| 150 | 94.5 | 94.5 | 94.5 |
| 200 | 94.5 | 95.0 | 95.4 |

| **CLOSED MOTORS** | | | |
| --- | --- | --- | --- |
| **RPM** | **1200** | **1800** | **3600** |
| **HP** |  |  |  |
| 1.0 | 81.5 | 84.0 |  |
| 1.5 | 85.5 | 85.0 | 84.0 |
| 2.0 | 86.5 | 84.0 | 85.5 |
| 3.0 | 88.5 | 88.5 | 86.5 |
| 5.0 | 88.5 | 88.5 | 87.5 |
| 7.5 | 89.5 | 91.0 | 88.5 |
| 10 | 89.5 | 91.0 | 89.5 |
| 15 | 90.2 | 91.0 | 89.5 |
| 20 | 91.0 | 91.7 | 90.2 |
| 25 | 91.7 | 92.4 | 90.2 |
| 30 | 92.4 | 93.6 | 91.0 |
| 40 | 93.0 | 93.0 | 91.0 |
| 50 | 93.6 | 93.6 | 92.4 |
| 60 | 93.6 | 94.1 | 94.1 |
| 75 | 94.1 | 94.5 | 94.1 |
| 100 | 94.1 | 95.0 | 94.1 |
| 125 | 94.1 | 95.0 | 94.1 |
| 150 | 95.0 | 95.0 | 94.1 |
| 200 | 95.0 | 95.8 | 95.01 |

Include subparagraph below when section 013510 is being used. Indicate which motors are to be eligible for the utility company rebate, and each motors efficiency requirement.

Furnish motors having an efficiency higher than that indicated above where specified to comply with utility company energy efficiency rebate program requirements.

* + - * 1. Motor (Nameplate) Voltage:

Select subparagraphs below. To suit.

Nominal 120/240 V, Single Phase, 3W, Premises Wiring System:

Motors Less Than 1/2 hp: NEMA standard motor voltage 115 V, single phase, 60 Hz.

Motors 1/2 hp and Larger: NEMA standard motor voltage 230 V, single phase, 60 Hz.

120/208 V, Three Phase, 4W, Premises Wiring Systems:

Motors Less Than 1 hp: NEMA standard motor voltage 115 V, single phase, 60 Hz.

Motors 1 hp and Larger: NEMA standard motor voltage 200 V, three phase, 60 Hz. 208 V, 208-230 V, 220 V, or 230 V motors are not acceptable.

277/480 V, Three Phase, 4W, Premises Wiring Systems:

Motors Less Than 1/2 hp: NEMA standard motor voltage 115 V, single phase, 60 Hz.

Motors 1/2 hp and Larger: NEMA standard motor voltage 460 V, three phase, 60 Hz. 440 V motors are not acceptable.

* + - * 1. Horsepower Capacity:

Each motor shall not be overloaded by the apparatus it operates under every condition of operation.

The horsepower capacity shall be the continuous rating based on the nameplate horsepower rating. (The motor may not be overloaded up to the horsepower obtained by multiplying the rated horsepower by the service factor shown on the nameplate).

Where a minimum horsepower capacity is listed, furnish a motor larger than the minimum, if required in a particular case.

Omit last five words in subparagraph below if combined single contract.

Pay additional cost due to necessary increase in feeder sizes, circuit breaker sizes, etc., provided under the Electric Contract.

* + - * 1. Bearings: Equip motors 1/2 hp and larger with ball bearings unless otherwise specified or indicated on the drawings.
        2. Speed: As required and approved to meet the requirements of the service for which motors are intended.

Space heaters are available for motors 1/2 hp and larger. Include space heaters for critical motors which are installed in damp or wet locations and that will not be frequently operated. A separate circuit is required for the heaters.

* + - * 1. Space Heaters: Where indicated, equip motors with space heaters and accessories to prevent condensation in the motor windings when motor is not operating.
        2. Motor Winding Protection: Where indicated, equip motors with imbedded temperature measuring detectors in the windings (thermocouples or resistance thermometers) with control unit and accessories for direct reading of stator temperatures. Alarm shall sound and motor controller trip at temperature recommended by motor manufacturer.
        3. Additional Requirements For Motors Used With Solid State and Adjustable Speed Motor Controllers:

Designed specifically for use with type of controller required.

Include subparagraph below if applicable. Coordinate with controller specifications.

Designed for DC injection braking.

* + - * 1. Brake: Where indicated, equip motors with electro/mechanical brake system.
      1. MANUAL AND MAGNETIC MOTOR CONTROLLERS
         1. Minimum Size: The minimum allowable size of single or three phase magnetic motor controller is NEMA size 0.
         2. Voltage Rating: To suit system voltage.

For single phase motor controllers which are not produced to suit the system voltage and phases, furnish properly rated 3 phase motor controllers and utilize required number of poles for the single phase circuit.

* + - * 1. Enclosures:

NEMA Type: Unless otherwise indicated, furnish NEMA 1 enclosures.

Material: Steel construction unless otherwise indicated.

Controllers other than type A, A1, or A2 are not available for flush mounting.

Type A, A1 and A2 Controllers Indicated To Be Flush Mounted: Furnish stainless steel face plates and galvanized steel recessed mounting boxes.

* + - * 1. Control Power: Furnish fused secondary control power transformer (maximum control voltage 120 volts) mounted within each magnetic motor controller enclosure.
        2. Local Control Devices:

Manual Motor Controllers:

Type A1 Controller: In addition to the on/off switch function, furnish where indicated, a hand/auto switch or 3 position hand-off-auto switch mounted in the enclosure cover.

Hand/auto not available for type A and A2 controllers.

Magnetic Motor Controllers: Equip controllers with push buttons, or 3 position hand-off-auto selector switch, (to suit operation) mounted in the enclosure cover.

For NEMA 1 enclosures furnish standard duty devices.

For other NEMA enclosures furnish heavy duty devices to suit the requirements of the NEMA enclosure.

* + - * 1. Pilot Lights:

Manual Motor Controllers: Equip controllers with pilot lights (neon) mounted in the enclosure cover.

Magnetic Motor Controllers: Equip controllers with pilot lights of the neon lamp type or transformer type, mounted in the enclosure cover.

When required, specify design parameters for paragraph below. See information at end of section - “brownout protection”.

* + - * 1. Time Delay Undervoltage Relays:

When required, specify design parameters for H. See information at end of section - “restarting motors after power outrage”.

* + - * 1. Sequenced Time Delay Relays:
        2. Space Heaters: Equip magnetic motor controllers which are installed outdoors, and indoors in unheated locations, with space heaters and humidistat to prevent condensation within the housing.
        3. Overload Devices: Equip motor controllers with manual reset melting type (eutectic), or manual reset bi-metallic type standard trip overload devices (NEMA Class 20, trips in 20 seconds or less when carrying a current equal to 600 percent of its current rating). Exceptions:

Automatic reset may be desirable where motor controller is not readily accessible. Do not indicate automatic reset where unexpected restart of motor could cause damage or injury. Do not indicate automatic reset where a number of restarts may damage motor or motor controller.

Equip motor controllers with automatic reset overload devices only where indicated.

Fast trip overload devices are used to protect special purpose motors having restricted thermal and locked rotor capabilities. Fast trip overload devices are used primarily with hermatic motors and submersible pumps.

Equip motor controllers with fast trip overload devices when recommended by equipment manufacturer (NEMA Class 10, trips in 10 seconds or less when carrying a current equal to 600 percent of its current rating).

Slow trip overload devices are used to protect motors with high inertial loads, such as flywheels and large fans where longer starting time is required.

Equip motor controllers with slow trip overload devices when recommended by equipment manufacturer (NEMA Class 30, trips in 30 seconds or less when carrying a current equal to 600 percent of its current rating).

A more positive method for protecting a remote motor is to specify thermostats, thermistors, or resistance temperature detectors installed in conjunction with the stator windings along with associated equipment which would cause motor controller to open upon motor overload. Consult motor manufacturer’s catalogs for details.

Equip motor controllers with ambient compensated overload protection where motor and relay are not in the same ambient.

Use solid state overload relays when more precise motor protection is desired. Specify the functions which are to be performed by the solid state overload relays. Consult manufacturer’s catalogs for application data.

Equip motor controllers with solid state overload relays where indicated.

* + - * 1. Manual Motor Controller Types:

Type A (Full Voltage, Non-Magnetic): Allen-Bradley Co.’s Bulletin 609, Cutler-Hammer Products’ File A/B300-9115, Furnas Electric Co.’s Class 11, General Electric Co.’s CR-1062, Square D Co.’s Class 2510, Type M, or Westinghouse Electric Corp.’s Type B100.

Type A1 (Full Voltage, Non-Magnetic Single Phase): Allen-Bradley Co.’s Bulletin 600, Cutler-Hammer Products’ File B200-9101, Furnas Electric Co.’s class 10, General Electric Co.’s CR-101, Square D Co.’s Class 2510, Type F, or Westinghouse Electric Corp.’s Type MS.

Type A2 (2 Speed, 2 Winding, Full Voltage, Non-Magnetic): Allen-Bradley Co.’s Bulletin 609TS, Cutler-Hammer Products’ File A700, General Electric Co.’s CR-1062, or Square D Co.’s Class 2512, Type M.

Type A3 (2 Speed, 2 Winding, Full Voltage, Non-Magnetic, Single Phase): Allen-Bradley Co.’s Bulletin 600, Cutler-Hammer Products’ File B200-9106, General Electric Co.’s CR-101, or Square D Co.’s Class 2512, Type F.

* + - * 1. Magnetic Motor Controller Types:

Type B (Full Voltage Magnetic): Allen-Bradley Co.’s Bulletin 509, Cutler-Hammer Products’ File A10-9586, Furnas Electric Co.’s Class 14, General Electric Co.’s CR-306, Square D Co.’s Class 8536, or Westinghouse Electric Corp.’s Class A200.

Type B-COM (Combination Full Voltage, Magnetic/Safety Switch): Allen-Bradley Co.’s Bulletin 512, Cutler-Hammer Products’ File A30-9589, Furnas Electric Co.’s Class 17, General Electric Co.’s, CR-308, Square D Co.’s Class 8538, or Westinghouse Electric Corp.’s Class A203.

Type B2 (2 Speed, 2 Winding, Full Voltage, Magnetic): Allen-Bradley Co.’s Bulletin 530, Cutler-Hammer Products’ File A700, Furnas Electric Co.’s Class 30, General Electric Co.’s CR-309, Square D Co.’s Class 8810, or Westinghouse Electric Corp.’s Class A900.

Type C (Automatic, Reduced Voltage Autotransformer, Magnetic): Allen-Bradley Co.’s Bulletin 570, Cutler-Hammer Products’ File A400-9621, Furnas Electric Co.’s Class 36, General Electric Co.’s CR-331, Square D Co.’s, Class 8606, or Westinghouse Electric Corp.’s Class A600.

Type C-Com (Combination Automatic, Reduced Voltage Autotransformer, Magnetic/Safety Switch): Allen-Bradley Co.’s Bulletin 572, Cutler-Hammer Products’ File A400-9621, Furnas Electric Co.’s Class 37, Square D Co.’s Class 8606, or Westinghouse Electric Corp.’s Class A603.

Type D (Part Winding, Magnetic): Allen-Bradley Co.’s Bulletin 530, Cutler-Hammer Products’ File A460-9612, Furnas Electric Co.’s Class 36, General Electric Co.’s CR-330, Square D Co.’s Class 8640, or Westinghouse Electric Corp’s Class A700.

* + - * 1. Remote Control Stations:

Normal Duty: Start-Stop with pilot light unless otherwise indicated, in NEMA 1 enclosure; Allen-Bradley Co.’s Bulletin 800S, Cutler-Hammer Products’ Bulletin 10250, Furnas Electric Co.’s Class 50, General Electric Co.’s CR-2943, Square D Co.’s Class 9001, or Westinghouse Electric Corp.’s Type PB1/PB2.

Heavy Duty: Start-Stop with pilot light unless otherwise indicated, in NEMA enclosure to suit conditions; Allen-Bradley Co.’s Bulletin 800T, Cutler-Hammer Products’ 10250T, Furnas Electric Co.’s Class 52, General Electric Co.’s CR104P, Square D Co.’s Class 9001, or Westinghouse Electric Corp.’s Type PB1/PB2.

* + - 1. SOLID STATE MOTOR CONTROLLERS

A type ss (solid state) specification should be written for each motor to suit its particular requirements.

* + - * 1. Type SS for Motor \_\_\_\_\_\_\_\_: Microprocessor controlled, solid state, stepless, reduced voltage motor controller:

Companies and Models: Furnish the Company’s model which meets the requirements of the motor and driven equipment combination, suits the electrical system parameters, and accommodates the operating features and accessories:

Allen-Bradley Co. Inc.’s Bulletin 2050 (30-120 hp, 208-575 V).

Furnas Electric Co.’s Class 93 (25-350 hp, 200-575 V).

General Electric Co.’s CR270 (20-1000 hp, 480 V).

Square D Co.’s Class 8660 (3-600 hp, 200-575 V).

Westinghouse Electric Corp.’s ES (5-1000 hp, 208-575 V).

Select features and accessories to suit each controller.

Operating Features And Accessories:

Also available 2, 3, & 4 speed.

Single speed.

Choose one of the next 3 subparagraphs. Subparagraph below is suitable for high starting torque loads such as positive displacement pumps, conveyors, mixers, cranes, etc.

Current ramp starting mode: Low initial current (starting at zero) gradually increasing to a maximum starting current value utilizing adjustable acceleration ramp time (rate of current increase). Once up to speed the current falls back to the motors running current.

Subparagraph below is suitable for centrifugal pumps, fans, and compressors.

Constant current starting mode: Motor receivers constant current within the current level limit adjustments. Once up to speed the current falls back to the motors running current.

Subparagraph below is suitable for applications requiring a precisely controlled acceleration time or linear rate of speed increase. Specify in the motor section that the motor be equipped with a tachometer.

Linear timed starting mode: Variable voltage and current controlled acceleration time/linear rate of speed increase, to operate in conjunction with the motor tachometer. Starting current does not exceed the motors running current.

Energy saver feature which automatically reduces voltage to lightly loaded motor.

Voltage limiter set to not exceed voltage rating of motor.

Subparagraph below may not be required for most pumps and fans since the controller itself can absorb and dissipate a limited amount of regenerative energy from the motor. Subparagraph below is required for equipment with a high inertia load, where coasting time may be limited due to system parameters. The controller cannot absorb all the regenerative energy within the required deceleration time, therefore dynamic braking must be used. DC injection braking is also available, but since the energy is dissipated in the motor, steps must be taken to prevent motor overheating.

Heavy duty dynamic braking which directs the regenerative energy from the motor into a resistor.

Include subparagraph below when the installation requires a holding torque at zero speed. Specify the brake in conjunction with the motor (see 2.01 j.).

Provision to energize electro/mechanical brake to hold the driven equipment stopped, after the motor has stopped.

If site conditions specified in subparagraph below exceed specified limits, take measures necessary to maintain ambient temperature and humidity at the controller within the specified limits.

Ambient operating temperature range 0 to 40 degrees C. Maximum humidity 95 percent.

Digital display, or meters with switches, showing operational functions:

Voltage.

Current.

Elapsed time.

Digital display, or LED’s showing diagnostic functions, including:

Phase loss.

Phase reversal.

Undervoltage.

Overtemperature.

Assess need for ground fault.

Ground fault.

State where remote alarm is to sound. Design and specify the remote alarm system.

Trouble alarm contact for remote alarm to \_\_\_\_\_\_\_\_.

Indicate short circuit current available at the controller.

Suitable for use on circuit capable of delivering \_\_\_\_\_\_\_\_ amps RMS short circuit fault current.

Change voltage in subparagraph below to 480 v when applicable.

Input voltage: Suitable for use on 208 V ac 3 phase circuit.

Change percentages in subparagraph below to 115 and 500 percent for heavy duty applications.

100 percent continuous current rating, 300 percent for 30 seconds.

Local control panel for manual operation:

Choose one of the next 3 subparagraphs.

Start-stop pushbuttons.

Hand-Off-Automatic selector switch.

Hand-Automatic selector switch, and start-stop pushbuttons.

Include subparagraph below if applicable

Forward-Reverse selector switch.

Include subparagraph below for 2 speed motor. Change to 3 or 4 speed if applicable.

Fast-Slow (for 2 speed motor).

Run light.

Local programming panel or other control method for:

Acceleration rate.

Deceleration rate.

Fused secondary control power transformer.

The start/stop control circuit can be 2 or 3 wire. Specify which in subparagraph below and explain operation of control device.

Start/stop control voltage maximum 120 V, \_\_\_\_\_\_\_\_ wire.

If subparagraph below is used, explain the function of the auxiliary contacts.

Auxiliary output contacts, 120 V ac, 1 amp:

Fault: 1 N.O., 1 N.O.

Overload Devices: Equip motor controller with manual reset solid state, manual reset melting type (eutectic), or manual reset bi-metallic type standard trip overload devices (NEMA Class 20, trips in 20 seconds or less when carrying a current equal to 600 percent of its current rating). Exceptions:

Automatic reset is available and may be desirable where motor controller is not readily accessible. Do not indicate automatic reset where unexpected restart of motor could cause damage or injury. Do not indicate automatic reset where a number of restarts may damage motor or motor controller. Fast trip overload devices are used to protect special purpose motors having restricted thermal and locked rotor capabilities. Fast trip overload devices are used primarily with hermatic motors and submersible pumps.

Equip motor controllers with fast trip overload devices when recommended by equipment manufacturer (NEMA Class 10, trips in 10 seconds or less when carrying a current equal to 600 percent of its current rating).

Slow trip overload devices are used to protect motors with high inertial loads, such as flywheels and large fans where longer starting time is required.

Equip motor controllers with slow trip overload devices when recommended by equipment manufacturer (NEMA Class 30, trips in 30 seconds or less when carrying a current equal to 600 percent of its current rating).

A more positive method for protecting a remote motor is to specify thermostats, thermistors, or resistance temperature detectors installed in the stator windings along with associated equipment which would cause motor controller to open upon motor overload (see 2.01 h.). Consult motor manufacturer’s catalogs for details.

Equip motor controllers with ambient compensated overload protection where motor and relay are not in the same ambient.

Select one enclosure type from the next 5 subparagraphs.

NEMA 1 enclosure.

NEMA 3 enclosure.

NEMA 3R enclosure.

NEMA 4 stainless steel enclosure.

NEMA 12 enclosure.

Select one of the next 2 subparagraphs.

Input circuit breaker/disconnect switch with external operator.

Input fusible disconnect switch with external operator.

Transient protective devices on input terminals; Innovative Technology Inc.’s P-Plus Protector.

Select one of the next 2 subparagraphs.

Manual bypass switch to allow the motor to be operated either from the solid state motor controller or across the line.

Automatic bypass switch to automatically switch to across the line operation upon solid state motor controller failure.

Include subparagraph below when motor must be completely isolated from the controller to insure that no voltage is present at the motor terminals, or leakage current from the controller switching devices cannot reach the motor windings.

Output isolation contactor to open circuit to motor whenever controller is in stop mode.

Specify desired functions of remote control station in subparagraph below if other than start/stop.

Remote control station, NEMA 1 enclosure, start-stop with pilot light; Allen-Bradley Co.’s Bulletin 800T, Cutler-Hammer Products’ 10250T, Furnas Electric Co.’s Class 52, General Electric Co.’s CR104P, Square D Co.’s Class 9001, or Westinghouse Electric Corp.’s Type PB1/PB2.

Provide additional operating features and accessories as required by the manufacturer of the equipment which the motor controller is driving.

* + - 1. ADJUSTABLE SPEED MOTOR CONTROLLERS

A Type AS-PWM (adjustable speed - pulse width modulation) specification should be written for each motor to suit its particular requirements. Delete underlining before adding information.

* + - * 1. Type AS-PWM for Motor: Microprocessor based, sine-coded pulse-width-modulation design variable frequency/variable voltage adjustable speed motor controller:

Companies and Models: Furnish the Company’s model which meets the requirements of the motor and driven equipment combination, suits the electrical system parameters, and accommodates the operating features and accessories:

Allen-Bradley Co. Inc.’s 1333 (3/4-50 hp/230 V, 1-5 hp/460 V), 1336 (1-100 hp/230 V, 1-500 hp/460 V), 1352 (25-1400 hp/460 V).

Asea Brown Boveri’s ACH500 (2-25 hp/230 V, 3-400 hp/460 V), ACS 200 (2-3 hp/230 V, 1-5 hp/460 V), SAMI STAR 30-1300 hp/460 V).

Eaton Corp.’s AF-1500 (1-20 hp/230 V, 1-30 hp/460 V, IS5000+ (5-600 hp/460 V).

Furnas Electric Co.’s Micro 7000 (2-25 hp/230 V, 2-60 hp/460 V), Super 7000+ (75-200 hp/460 V).

General Electric Co.’s AF-300B (3/4-30 hp/230 V, 1/4-300 hp/460 V).

Reliance Electric Co.’s GP2000 (1/4-50 hp/230 V, 1/4-100 hp/460 V).

Southcon Industrial Controls Inc.’s Magnum PWM (1/4-200 hp/230 V, 1/4 to 400 hp/460 V).

Square D Co.’s Class 8804 Omegapak (1-150 hp/230 V, 1-300 hp/460 V).

Westinghouse Electric Corp.’s Accutrol 110 (1-75 hp/230 V, 2-20 hp/460 V).

Select features and accessories to suit each controller.

Operating Features And Accessories:

Choose one of next 2 subparagraphs to suit the driven equipment. Variable torque load is typical for centrifugal pumps and fans. Constant torque load is typical for positive displacement pumps, conveyors, hoists, and compressors. Also available for constant horsepower (typical for factory machines) and impact loads (such as stamping press). Constant torque and variable torque loads usually run at the motors nameplate rated speed, or less (constant torque 0-60 hz, variable torque 30-60 hz). Constant hp is usually applied above motor base speed (60-120 hz). In any case motor and driven equipment overheating and overspeed ability must be assessed at any output frequency over 60 hz.

Suitable for variable torque load.

Suitable for constant torque load.

Select one of next 2 subparagraphs. Subparagraph below is standard starting method. Second subparagraph below is used to avoid impact damage to driven machine or process.

Soft start: Adjustable time range of 2 to 600 seconds.

Cushioned start: Timed acceleration/deceleration linearly in steps up to the preset speed.

Omit subparagraph below if not applicable.

Reversing.

Select any (or all) of the next 3 subparagraphs if applicable. First 2 subparagraphs below may not be required for most pumps and fans since the controller itself can absorb and dissipate a limited amount (approximately 20 percent of rated current) of regenerative energy from the motor. First subparagraph below is required for equipment with a high inertia load, where coasting time may be limited due to system parameters. The controller cannot absorb all the regenerative energy within the required deceleration time, therefore regenerative or dynamic braking must be used. Regenerative braking is preferred since it directs the energy back into the ac line, thus saving the energy. Consider dynamic braking when the motor does not have to stop frequently, thus keeping energy loss thru the resistors to a minimum.

Regenerative braking which directs the regenerative energy from the motor back into the ac line.

Heavy duty dynamic braking which directs the regenerative energy from the motor into a resistor.

Dc injection braking is available (subparagraph below), but since the energy is dissipated in the motor, steps must be taken to prevent motor overheating (see 2.01 i.).

DC injection braking to bring motor to stop.

Include subparagraph below when the installation requires a holding torque at zero speed. Specify the brake in conjunction with the motor (see 2.01 j.).

Provision to energize electro/Mechanical brake to hold the driven equipment stopped, after the motor has stopped.

Ground fault protection.

If site conditions specified in subparagraph below exceed specified limits, take measures necessary to maintain ambient temperature and humidity at the controller within the specified limits.

Ambient operating temperature range 0 to 40 degrees C. Maximum humidity 95 percent.

Digital display showing operational functions:

Speed.

Output voltage.

Output current.

Elapsed time.

Digital display, or LED’s showing diagnostic functions, including:

Overcurrent.

Overvoltage.

Undervoltage.

Overtemperature.

Ground fault.

Overload.

State where remote alarm is to sound in subparagraph below. Design and specify the remote alarm system if it is not a function of the buildings direct digital control system.

Fault alarm contact for remote alarm to \_\_\_\_\_\_\_\_.

Indicate short circuit current available at the controller. Delete underling before adding information.

Suitable for use on circuit capable of delivering \_\_\_\_\_\_\_\_ amps RMS short circuit fault current.

Change voltage in subparagraph below to 480 v when applicable.

Input voltage: Suitable for use on 208 V ac 3 phase circuit.

Change voltage in subparagraph below to 480 v when applicable.

Output voltage 0 to 208 V ac, 3 phase.

Frequency:

Input: 60 Hz.

Modify selectable output range to suit in subparagraph below. Constant torque and variable torque loads usually run at the motors nameplate rated speed, or less (constant torque 0-60 hz, variable torque 30-60 hz). Constant hp is usually applied above motor base speed (60-120 hz). In any case motor and driven equipment overheating and overspeed ability must be assessed at any output frequency over 60 hz.

Selectable Output: 3 to 60 Hz, with separately adjustable min/max frequency limits and capability to lock these limits so that they cannot be exceeded.

Frequency Reject: Programmable (both the width and the midpoint of up to 3 bands, or end points) to reject operation within the selected bands.

Output regulation: + .06 percent.

100 percent continuous current rating, 150 percent for one minute every 10 minutes.

Local control panel for manual operation:

Select one of the next 3 subparagraphs.

Start-stop pushbuttons.

Hand-Off-Automatic selector switch.

Hand-Automatic selector switch, and start-stop pushbuttons.

Include subparagraph below if appropriate and modify to suit.

Forward-Reverse selector switch, with timer, for maximum operation of 20 minutes when in service.

Manual speed potentiometer.

Power on light.

Run light.

Local programming panel for:

Acceleration rate.

Deceleration rate.

Start torque (boost).

Maximum frequency.

Volts/Hz pattern.

Select one of next 2 subparagraphs to suit.

Restart Mode: Automatic restart upon return of input power, manual reset/restart on overload.

Restart Mode: Manual reset/restart upon return of input power or overload.

Start and direction, local or remote.

Stop mode, ramp or coast.

Select one of next 2 subparagraphs suit and modify as required to suit exact speed control requirements.

Interface Input For Automatic Speed Control: Isolated, direct proportional automatic speed follower which responds to an externally supplied signal from the speed reference signal source for automatic motor speed control when the controller is in the automatic mode of operation.

0-10 V dc.

4-20mA dc.

Variable resistance.

3 to 15 psi pneumatic/electric transducer.

Interface Input For Automatic Speed Control: Interface which accepts signals from programmable logic control, or computer, for automatic speed and direction control when the controller is in the automatic mode of operation.

Include subparagraph below when applicable.

Interface Input For Emergency Stop: Isolated input to receive signal from the fire alarm system, to stop motor upon alarm condition.

Include subparagraph below when applicable. Coordinate with section 230923.

Interface Output To Indicate Speed: Interface which follows motor speed, enabling the motor speed to be displayed at the Direct Digital Building Control System primary operator station.

The start/stop control circuit can be 2 or 3 wire. Specify which, and explain operation of control device in subparagraph below.

Start/stop control voltage maximum 120 V, wire.

If subparagraph below. is used, explain the function of the auxiliary contacts.

Auxiliary output contacts, 120 V ac, 1 amp:

Spares, for future use: 1 N.O., 1 N.C.

Coordinate subparagraph below with section 230923.

For Remote Indication at the Direct Digital Building Control System Primary Operation Station:

Run: 1 N.O.

Fault: 1 N.O., 1 N.C.

At Speed: 1 N.O.

Motor overload devices in the controller (such as subparagraph below) actually monitors the motor current to determine motor temperature. For optimum motor protection also include cc. Specify in the motor section that the motor be equipped with imbedded temperature measuring detectors in the windings (thermocouple or resistance thermometers), or stator winding thermostats, for direct reading of winding temperature, with control unit and accessories compatible for operation with the adjustable speed motor controller (see 2.01 h.).

Electronic overload device that monitors the motor function to provide motor overload protection at all speeds. Manual or automatic reset as specified under local programming panel.

Motor winding protection, responsive to the motors’ imbedded temperature measuring detectors.

Select enclosure type from next 7 subparagraphs.

NEMA 1 enclosure.

NEMA 1 enclosure with fans and filter.

NEMA 3 enclosure.

NEMA 3R enclosure.

NEMA 4 stainless steel enclosure.

NEMA 12 enclosure.

NEMA 12 available with air conditioning thru 290kva.

NEMA 12 enclosure with closed loop air conditioner.

Select one of the next 2 subparagraphs.

Input circuit breaker/disconnect switch with external operator.

Input fusible disconnect switch with external operator.

Change 5 percent to 3 percent for hospitals, labs, computers, and other special applications.

Controllers designed, equipped, and installed such that the controllers reflect 5 percent or less total harmonic distortion at the source specified under System Acceptance Test. Equip controller with:

Input isolation/voltage matching transformer, or 3 percent input line reactor if voltage matching is not required.

Transient protective devices on input terminals; Innovative Technology Inc.’s P-Plus Protector.

Additional equipment (line filters, etc.) as recommended by the adjustable speed motor controller manufacturer to maintain total harmonic distortion below specified level.

Include subparagraph below for existing system. Fill in required data.

Basic Parameters Relative to the Existing System:

Distribution Transformer Size: \_\_\_\_\_\_\_\_ KVA.

Distribution Transformer Impedance: \_\_\_\_\_\_\_\_ percent.

List existing feeder sizes from the distribution transformer to the distribution panel(s) to the controller.

Conductors:

1. Feeder No. Size Distance

Subparagraph below is useful, but optional data.

Short circuit current available at distribution transformer: \_\_\_\_\_\_\_\_ amperes.

Choose one of next 2 subparagraphs.

Manual bypass switch to allow the motor to be operated either from the drive or full speed across the line.

Solid state, soft start, or reduced voltage magnetic motor controller arranged and wired to operate motor when switch is in bypass mode. Across-the-line magnetic motor controller may be used for motors less than 7-1/2 hp (208 V), 15 hp (480 V).

Automatic bypass switch to automatically switch to full speed across the line operation upon drive fault (except short circuit, ground fault, or motor thermal overload).

Solid state, soft start, or reduced voltage magnetic motor controller arranged and wired to operate motor when switch is in bypass mode. Across-the-line magnetic motor controller may be used for motors less than 7-1/2 hp (208 V), 15 hp (480 V).

Include subparagraph below. When motor must be completely isolated from the controller to insure that no voltage is present at the motor terminals, or leakage current from the controller switching devices cannot reach the motor windings.

Output isolation contactor to open circuit to motor whenever controller is in stop mode.

Include subparagraph below if a disconnect switch is going to be used on the load side of the adjustable speed motor controller. Coordinate with electrical designer.

Interlock system to prevent the load side disconnect switch (at the motor) from being opened while the adjustable speed motor controller is energized. Motor controller input disconnect must be opened before load side disconnect switch can be opened. Coordinate interlock system with Electrical Work Contractor.

Remote operator station, NEMA 1 enclosure:

Select desired functions.

Start.

Stop.

Frequency (Speed).

Forward/Reverse.

Provide additional operating features and accessories as required by the manufacturer of the equipment which the adjustable speed motor controller is driving.

Include article below for adjustable speed controllers.

* + - 1. HARMONICS METER
         1. Dranetz-BMI’s 155 Harmonics Meter with capability for measuring amperage harmonics, 1000 New Durham Road, Edison, NJ 08818-4019, (800) 372-6832, or (732) 287-3680; Fax: (732) 248-1834.
      2. NAMEPLATES
         1. General: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inch high.

Phenolic: Two color laminated engraver’s stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).

Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.

Materials for Outdoor Applications: As recommended by nameplate manufacturer to suit environmental conditions.

1. EXECUTION
   * + 1. INSTALLATION
          1. Install the Work of this Section in accordance with the manufacturer’s printed instructions.
          2. Nameplates: Identify each remote control station, indicating motor controlled. Identify each interlock switch, indicating purpose of switch:

NEMA 1 Enclosures: Rivet or bolt nameplate to the cover.

NEMA 12 Enclosures: Rivet or bolt and gasket nameplate to the cover.

NEMA 3R, 4, 4X, 7, or 9 Enclosures: Attach nameplates to the cover using adhesive specifically designed for the purpose, or mount nameplate on wall or other conspicuous location adjacent to switch. Do not penetrate enclosure with fasteners.

1. REMOTE CONTROL STATION SCHEDULE
   * + - 1. Use normal duty remote control stations in dry non-hazardous locations. Use heavy duty remote control stations in all other locations.

Include article below only for solid state and adjustable speed controllers.

* + - 1. FIELD QUALITY CONTROL
         1. Preliminary System Test:

Preparation: Have the Company Field Advisor program and adjust the completed solid state and adjustable speed motor controllers and then operate them long enough to assure that they are performing properly.

Run a preliminary test for the purpose of:

Determining whether motor controllers are in a suitable condition to conduct an acceptance test.

Checking instruments and equipment.

Training facility personnel.

* + - * 1. System Acceptance Test:

Preparation: Notify the Director’s Representative at least 3 working days prior to the test so arrangements can be made prior to the test to have a Facility Representative witness the test.

Make the following tests:

Demonstrate that each solid state and adjustable speed motor controller performs its intended function.

Use the harmonics meter to determine the total harmonic distortion caused by the adjustable speed motor controllers.

Use subparagraph below for new electrical system.

While the motors are running, measure the total harmonic distortion at the transformer serving the building.

Use subparagraph below for existing electrical system.

While the motors are running, measure the total harmonic distortion at the distribution transformer supplying the controllers.

If total harmonic distortion caused by the adjustable speed motor controllers exceeds specified limit, install additional equipment as necessary to keep the total harmonic distortion caused by the adjustable speed motor controllers under the specified limit.

Supply all equipment necessary for system adjustment and testing.

Use subparagraph below if the connected load of the motors associated with the adjustable speed controllers is 40 percent or more of the transformer serving the building (new electrical system) or 40 percent or more of the distribution transformer supplying the controllers (existing electrical system). Use second subparagraph below when first subparagraph is not applicable.

The harmonics meter shall remain the property of the State.

The harmonics meter shall remain the property of the Contractor.

Submit written report of test results signed by the Company Field Advisor and the Director’s Representative. Mount a copy of the final report in a plexiglass enclosed frame assembly in a conspicuous location on or adjacent to each motor controller.

Include article below unless all controller types are indicated on drawings by schedule or symbols.

* + - 1. MOTOR CONTROLLER SCHEDULE
         1. Types of Motor Controllers Required For Single Speed Motors, Unless Indicated Otherwise On Drawings:

Select and edit next 3 subparagraphs to suit.

Nominal 120/240 V, Single Phase, 3W, Premises Wiring System:

Single Phase Motors 5 hp or Less - Manually Operated: Type A. Exception: Type A1 may be used for motors 1 hp or less.

Single Phase Motors 5 hp or Less - Automatically Operated: Type B. Exception: Type A or Type A1 may be used for motors less than 1/2 hp when the automatic auxiliary controlling device (thermostat, pressure switch, etc.) is rated for the voltage and current requirements of the motor.

120/208 V, Three Phase, 4W, Premises Wiring System:

Single Phase Motor Less Than 1 hp - Manually Operated: Type A or Type A1.

Single Phase Motors Less Than 1 hp - Automatically Operated: Type B. Exception: Type A or Type A1 may be used for motors less than 1/2 hp when the automatic auxiliary controlling device (thermostat, pressure switch, etc.) is rated for the voltage and current requirements of the motor.

Consult with electric designer and change 7-1/2 hp in next 4 subparagraphs to higher hp if recommended.

Three Phase Squirrel Cage Motors Less Than 7-1/2 hp - Manually or Automatically Operated: Type B-COM (B when indicated on drawing) or Type SS.

Three Phase Squirrel Cage Motors 7-1/2 hp and Larger - Manually or Automatically Operated: Type C-COM (C when indicated on drawings) or Type SS.

Three Phase Hermetically Sealed Compressor Motors Less Than 7-1/2 hp - Automatically Operated: Type B or Type SS.

Three Phase Hermetically Sealed Compressor Motors 7-1/2 hp and Larger - Automatically Operated: Type D or Type SS.

277/480 V, Three Phase, 4W, Premises Wiring System:

Single Phase Motors Less than l/2 hp - Manually Operated: Type A or Type A1.

Single Phase Motors Less Than 1/2 hp - Automatically Operated: Type B. Exception: Type A or Type A1 may be used when the automatic auxiliary controlling device (thermostat, pressure switch, etc.) is rated for the voltage and current requirements of the motor.

Consult with electric designer and change 7-1/2 hp in next 4 subparagraphs to higher hp if recommended.

Three Phase Squirrel Cage Motors Less than 15 hp - Manually or Automatically Operated: Type B-COM (B when indicated on drawings) or Type SS.

Three Phase Squirrel Cage Motors 15 hp and Larger - Manually or Automatically Operated: Type C-COM (C when indicated on drawings) or Type SS.

Three Phase Hermetically Sealed Compressor Motors Less than 15 hp - Automatically Operated: Type B or Type SS.

Three Phase Hermetically Sealed Compressor Motors 15 hp and Larger - Automatically Operated: Type D or Type SS.

* + - * 1. Types of Motor Controllers Required For 2 Speed Motors, Unless Indicated Otherwise on Drawings:

Select and edit next 3 subparagraphs to suit.

Nominal 120/240 V, Single Phase, 3W, Premises Wiring System:

Single Phase Motors 5 hp or Less - Manually Operated: Type A2. Exception: Type A3 may be used for motors 1 hp or less.

Single Phase Motors 5 hp or Less - Automatically Operated: Type B2.

120/208 V, Three Phase, 4W, Premises Wiring System:

Single Phase Motors Less Than 1 hp - Manually Operated: Type A2. Exception: Type A3 may be used for motors 1/2 hp or less.

Single Phase Motors Less Than 1 hp - Automatically Operated: Type B2.

Three Phase Squirrel Cage Motors Less Than 7-1/2 hp - Manually or Automatically Operated: Type B2 or Type SS.

Three Phase Squirrel Cage Motors 7-1/2 hp and Larger: Type SS.

277/480 V, Three Phase, 4W, Premises Wiring System:

Single Phase Motors Less Than 1/2 hp - Manually Operated: Type A2 or Type A3.

Single Phase Motors Less Than 1/2 hp - Automatically Operated: Type B2.

Three Phase Squirrel Cage Motors Less Than 15 hp - Manually or Automatically Operated: Type B2 or Type SS.

Three Phase Squirrel Cage Motors 15 hp and Larger: Type SS.

* + - * 1. Types of Motor Controllers Required For Variable Speed Applications:

Three Phase Premises Wiring System:

Three Phase Motors 1 to 800 hp: Type AS-PMW.

END OF SECTION 260221

The remainder of this section is for information only - not to be included in project specifications.

1. For Controllers: Indicate on the drawings of the trade supplying controllers, the following for each motor controller:

a. Controller type.

b. Type of enclosure if other than NEMA 1.

c. Type of material if other than steel.

d. Number of poles.

e. NEMA Size.

2. For Motors:

a. Indicate on the drawings or in appropriate sections of the specification of the trade supplying motors, the type of motor housing required if other than drip proof (totally-enclosed fan cooled, encapsulated, explosion-proof, splash-proof, etc.).

3. NEMA STANDARD MOTOR VOLTAGES:

a. Wherever a voltage is indicated in conjunction with a motor, state the NEMA motor voltage, not the system voltage.

| SYSTEM VOLTAGE | NEMA MOTOR VOLTAGE |
| --- | --- |
| 120 V, Single Ph. | 115 V |
| 240 V, Single Ph. | 230 V |
| 208 V, 3 phase | 200 V |
| 240 V, 3 phase | 230 V |
| 480 V, 3 phase | 460 V |

4. Restarting Motors After Power Outage:

a. Automatically operated (2 wire control) magnetic controllers will cause the motors to come back on the line immediately upon restoration of power thru the normal source, or by means of the standby system. Investigate capacity of normal and standby sources. If either source is inadequate to simultaneously pick up the lighting load plus starting the motors, install sequenced time delay relays in the larger motor controllers. Coordinate timing sequence, specify system parameters and show wiring diagrams. Automatically operated controllers that cause motors to start immediately upon restoration of power may, in some cases, pose a danger of damage or injury.

b. Manually operated magnetic controllers (on/off 3 wire control) drop out upon power failure and will not restart until manually reset.

5. Brownout Protection: Magnetic controllers will not release until control voltage is approximately 60 percent of normal (restorable at 85 percent), which will not prevent motor burnouts under brownout or other low voltage conditions. If required to prevent motor burnout during sustained low voltage condition, install time delay undervoltage relays in the controllers. Accessories are available, but parameters must be specified. Example for 208 V circuit: Motor controller shall release when voltage is 185 volts or less for more than 10 seconds. Motor controller shall cause motor to come back on the line when voltage is restored to at least 195 volts.

6. Codes, Standards and References applicable to motors and motor controllers:

a. National Electrical Code - Article 430, 440.

b. National Electrical Manufacturers Association (NEMA):

1) ICS 1 - General Standards for Industrial Control and Systems.

2) ICS 1.1 - Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control.

3) ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

4) ICS 2.3 - Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.

5) ICS 3 - Industrial Systems.

6) ICS 6 - Enclosures for Industrial Controls and Systems.

7) MG 1 - Motors and Generators.

8) MG 2 - Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors.

9) MG 3 - Sound Level Prediction for Installed Rotating Electrical Machines.

10) MG 10 - Energy Guide for Selection and Use of Polyphase Motors.

11) MG 11 - Energy Management Guide for Selection and Use of Single Phase Motors.

c. Underwriters Laboratories Inc.:

1) UL508 - Electric Industrial Control Equipment.

2) Subject 508C - Outline of Investigation for Power Conversion Equipment.

d. IEEE:

1) IEEE 519 - IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.

END OF INFORMATION