Specification Number: 26 24 19.30 AR
Product Name: LOW VOLTAGE INDUSTRIAL MOTOR CONTROL CENTERS

SECTION 26 24 19.30
LOW VOLTAGE INDUSTRIAL MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. This section includes requirements for a motor control center (MCC) and all required control devices as shown on the drawing and specified to be part of the MCC equipment. The MCC shall be 480 V, 3-Phase, 3-Wire, 60 Hz unless otherwise indicated.

1.03 STANDARDS

A. Equipment shall be manufactured in a certified ISO 9001 facility and shall be designed and tested to the following standards:

1. UL 845, UL Listed
2. National Electrical Manufacturers Association (NEMA) ICS 18-2001
3. NEMA ICS 2.3 – Instruction for Handling, Operation and Maintenance of Motor Control Centers
4. Canadian Standards Association – (CSA) C22.2 No. 254-05
5. Electrical Equipment Manufacturers Association of Canada (EEMAC)
6. National Electrical Code - NFPA 70
7. **[Motor Control Centers rated for arc resistance shall be provided and tested according to the IEEE C37.20.7-2007 "IEEE Guide for Testing Metal Enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults." MCCs shall be provided with documentation and labeling indicating equipment is rated for these applications. Tests shall be witnessed and certified by a UL representative.]**

1.04 RELATED SECTIONS

A. 26 01 20.17 - Low Voltage Power Circuit Breakers
B. 26 28 16.14 - Molded Case Circuit Breakers
C. 26 09 13.20 - Electrical Controls – Relays and Pushbuttons
D. 26 09 13.80 - Web-enabled Power Distribution Equipment
E. 26 43 13 - SPD in Low Voltage MCCs
F. 26 35 26.11 - Low Voltage Active Harmonic Filters

PART 2 PRODUCT

2.01 MANUFACTURERS

A. Low Voltage Motor Control Center shall be Square D by Schneider Electric ® brand Model 6 MCC.

2.02 MATERIALS

A. Steel material shall comply with UL 845 and CSA requirements.

B. Each MCC shall consist of one or more vertical sections of heavy gauge steel bolted together to form a rigid, free-standing assembly. A removable 7 gauge structural steel lifting angle shall be mounted full width of the MCC shipping block at the top. Removable 7 gauge bottom channel sills shall be mounted underneath front and rear of the vertical sections extending the full width of the shipping block. Vertical sections made of welded side-frame assembly formed from a minimum of 12 gauge steel. Internal reinforcement structural parts shall be of 12 and 14 gauge steel to provide a strong, rigid assembly. The entire assembly shall be constructed and

packaged to withstand normal stresses included in transit and during installation.

2.03 MCC FINISH

A. All steel parts shall be provided with UL and CSA listed acrylic/alkyd baked enamel paint finish or TGIC Powder Coat, except plated parts used for ground connections. All painted parts shall undergo a multi-stage treatment process, followed by the finishing paint coat.

B. Pre-treatment shall include:

1. Hot alkaline cleaner to remove grease and oil.
2. Iron phosphate treatment to improve adhesion and corrosion resistance.

C. The paint shall be applied using an electro-deposition process to ensure a uniform paint coat with high adhesion.

D. The standard paint finish shall be tested to UL 50 per ASTM B117 (5% ASTM Salt Spray) with no greater than 0.125 in (3 mm) loss of paint from a scribed line.

E. Paint color shall be #49 medium light gray per ANSI standard Z55.1-967 (60-70 gloss) on all surfaces unless specified otherwise. Control station plates and escutcheon plates shall be painted a contrasting gray. All unit interior saddles shall be painted white for better visibility inside the unit.

2.04 STRUCTURES

A. Structures shall be totally enclosed, dead-front, free-standing assemblies. Structures shall be capable of being bolted together to form a single assembly.

B. The overall height of the MCC shall not exceed 90 in (2286 mm) (not including base channel, lifting angle, baffle, or plenum). Base channels, of 1.5 in (38 mm) in height, and lifting angles, of 3 in (76 mm) in height, shall be removable. The total width of one section shall be 20 in (508 mm); (widths of 25 in (630 mm), 30 in (760 mm), and 35 in (890 mm) can be used for larger devices).

C. Structures shall be NEMA/EEMAC type **[1 (general purpose)] [1A (gasketed general purpose)] [12 (industrial duty)] [3R non-walk-in (rainproof)].**

D. Each 20 in. (508 mm) wide standard section shall have all the necessary hardware and bussing for modular plug-on units to be added and moved around. All unused space shall be covered by hinged blank doors or appropriate cover plate and equipped to accept future units. Vertical bus openings shall be covered by manual bus shutters.

E. Each section shall include a top plate (single piece or two-piece). **[MCCs rated for arc resistance shall have single piece top plate with exhaust flaps as specified in 2.04 G below]** NEMA/EEMAC type 12 shall also include a bottom plate. Top and bottom plates shall be removable for ease in cutting conduit entry openings.

F. **[MCCs rated for arc resistance shall provide Type 2 Accessibility as defined by IEEE C37.20.7-2007 'IEEE Guide for Testing Metal-enclosed Switchgear Rated up to 38 kV for Internal Arcing Faults'.]**

G. **[MCCs rated for arc resistance shall have a Gas Management System that redirects and exhausts all arc fault yielding pressures and gases through a chimney chute out of the top of the MCC. The internal portion of the Gas Management System shall include unit midshelves fitted with breathable openings that redirect arc fault pressures and gases out of the unit towards the arc exhaust chimney. The external portion of the Gas Management System shall include MCC top plates designed with hinged flaps that allow for exhausting of arcing gases out of the top of the MCC. MCC shall be available with optional field-installable plenum assembly which provides continuous reinforced duct for directing arc flash energy outside MCC room.]**

2.05 WIREWAYS

A. Structures shall contain a minimum 12 in (305 mm) high horizontal wireway at the top of each section and a minimum 6 in (152 mm) high horizontal wireway at the bottom

of each section. These wireways shall run the full length of MCC to allow room for power and control cable to connect between units in different sections.

B. A full-depth vertical wireway shall be provided in each MCC section that accepts modular plug-on units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4 in. (102 mm) wide minimum with a separate hinged door. There should be a minimum of 60 $in.^2$ (387 cm^2) of cabling space available for 15-inch-deep sections and 80 $in.^2$ (516 cm^2) of cabling space available for 20-inch-deep sections. Access to the wireways shall not require opening control unit doors. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units must open directly into the MCC horizontal wireways.

C. **[Vertical wireway doors on MCCs rated for arc resistance shall be 12 gauge steel and have additional fasteners/receptacles installed for reinforcement from arc blast pressure]**

2.06 BARRIERS

A. All power bussing and splice connections shall be isolated from the unit compartments and the wireways. The horizontal bus shall be mounted onto a glass filled polyester support assembly that braces the bus against the forces generated during a short circuit. The horizontal bus shall be isolated from the top horizontal wireway by a two-piece rigid non-conductive barrier. The barrier design shall allow qualified personnel to slide the barriers both left and right, to allow access to the bus and connections for maintenance without having to remove the barrier. Barrier sliding shall occur via an upper and lower track system.

B. The vertical bus shall be housed in a molded glass-filled polyester support that provides bus insulation and braces the bus against the forces generated during a short circuit. These supports shall have openings every 3 in (75 mm) for unit stab-on connections. Each opening shall be provided with a manual shutter to close off the stab opening. These shutters shall be attached to the structure so that when they are removed (to allow a stab connection) they are retained in the structure and are readily accessible for use should a plug-in unit be removed from the MCC.

C. [Barriers shall be provided in the vertical structure and unit designs to prevent the contact of any energized bus or terminal by a fishtape inserted through the conduit or wireway areas.]

D. [Automatic shutters shall be provided for each plug-on unit which will automatically close to cover the vertical bus opening with a non-conductive shutter when the unit is removed from the MCC and automatically open the vertical bus opening as the unit is inserted in the same location in the MCC.

2.07 BUSSING

A. All bussing and connectors shall be **[tin-plated aluminum] [tin-plated copper] [silver-plated copper]**.

B. The main horizontal bus shall be rated at **[600 A] [800 A] [1200 A] [1600 A] [2000 A] [2500 A (NEMA/EEMAC Type 1 enclosure only)]** continuous and shall extend the full length of the MCC. Bus ratings shall be based on 65° C maximum temperature rise in a 40° C ambient. Provisions shall be provided for splicing additional sections onto either end of the MCC. **[STAGE 1: MCCs rated for arc resistance shall have main horizontal bus rated at [600 A] [800 A] [1200 A] [1600 A] [2000 A]] [STAGE 2: MCCs rated for arc resistance shall have horizontal bus rated at [600 A] [800 A] [1200 A] [1600 A] [2000 A] [2500 A (NEMA/EEMAC Type 1 enclosure only)]**

C. The horizontal bus splice bars shall be pre-assembled into a captive bus stack. This bus stack is installed into the end of the MCC power bus to allow the installation of additional sections. The main bus splice shall utilize four bolts, two on each side of the bus split, for each phase. Additional bolts must not be required when splicing

higher amperage bus. The splice bolts shall secure to self clenching nuts installed in the bus assembly. It shall be possible to maintain any bus connection with a single tool. **[MCCs shall be fitted with an epoxy coated, insulated horizontal bus. The horizontal bus joints shall be covered by an insulating box consisting of tabs and slots which can be opened and closed without tools for ease of joint maintenance.]**

D. Each section that accepts plug-in units shall be provided with a vertical bus for distributing power from the main bus to the individual plug-in starter units. This bus shall be of the same material and plating as the main bus, and shall be rated at **[300 A] [600 A]** continuous. The vertical bus shall be connected directly to the horizontal bus stack without the use of risers or other intervening connectors. It shall be possible to maintain the vertical to horizontal bus connection with a single tool. "Nut and bolt" bus connections to the power bus shall not be permitted. When a back-to-back unit arrangement is utilized, separate vertical bus shall be provided for both the front and rear units.

E. A **[tin-plated copper] [silver-plated copper]** ground bus shall be provided that runs the entire length of the MCC. **[The ground bus shall be 0.25 in (6.0 mm) x 1.0 in (25 mm) and be rated for 300 A] [The ground bus shall be 0.25 in (6.0 mm) x 2.0 in (50 mm) and be rated for 600 A]**. A mechanical lug shall be provided in the MCC for a #8 -250 kcmil ground cable. The ground bus shall be provided with (6) 0.38 in (10 mm) holes for each vertical section to accept customer-supplied ground lugs for any loads requiring a ground conductor.

F. Each vertical section shall have a **[steel] [copper]** vertical ground bus that is connected to the horizontal ground bus. This vertical ground bus shall be installed so that the plug-in units engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected upon removal of the plug-in unit.

G. The system shall be rated for an available short circuit capacity of **[42,000] [65,000] [85,000] [100,000]** rms amperes. **[MCCs rated for arc resistance shall be rated for an available short circuit capacity of [42,000] [65,000] rms amperes up to 600 volts.]**

H. STAGE1: **[MCCs rated for arc resistance shall be protected upstream of the MCC by a Square D brand Masterpact NT/NW or PowerPact P/R frame circuit breaker, or a class L fused disconnect upstream of the MCC. MCC shall be rated for an arc duration of 100 milliseconds (device limited).]**

STAGE 2: **[MCCs rated for arc resistance shall contain a Masterpact ArcBlok™ NT/NW or PowerPact H/J/L/M/P/R frame circuit breaker, main lug, or fusible disconnect switch. MCC shall be rated for an arc duration of 500 milliseconds (30 cycles).]**

2.08 TYPICAL UNIT CONSTRUCTION

A. Units with circuit breaker disconnects through 400 A frame, and fusible switch disconnects through 400 A, shall connect to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

B. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material to prevent accidental contact with those parts.

C. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All plug-on units shall use a twin-handle camming lever located at the top of the bucket to rack in and out the plug-on unit. The cam lever shall work in conjunction with the hanger brackets to ensure positive stab alignment.

D. A lever handle operator must be provided on each disconnect. With the unit stabs engaged onto the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit. All circuit breaker operators shall

include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door. Clear indication of disconnect status shall be provided, by adhering to the following operator handle positions:

1. Handle "On" position must be up or to the left and within 45 degrees of being parallel to the face of the equipment.
2. Handle "Off" position must be down or to the right and within 45 degrees of being parallel to the face of the equipment.
3. The minimum separation between the "On" and "Off" positions shall be 90 degrees.
4. On Circuit Breaker disconnects, the handle "Tripped" position must be perpendicular to the face of the equipment +/- 30 degrees. Minimum separation between "On" and "Tripped" shall be 30 degrees. Minimum separation between "Tripped" and "Off" shall be 45 degrees.

E. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.

F. A non-defeatable interlock shall be provided to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position.

G. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.

H. Provisions shall be provided for locking all disconnects in the OFF position with up to three padlocks.

I. Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.

J. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.

K. **[Surfaces (back, side and bottom plates) of the unit interior shall be painted white.]**

L. **[MCCs rated for arc resistance and fitted with fixed mounted disconnects shall be sealed with solid door or spring-loaded sealing frame to minimize arc flash energy escaping from enclosure.]**

2.09 COMPONENTS FOR TYPICAL UNITS

A. Combination Starters

1. All combination starters shall use a unit disconnect as described in specification 2.08. Magnetic starters shall be furnished in all combination starter units. All starters shall utilize NEMA/EEMAC rated contactors. Starters shall be provided with a three-pole, external manual reset, overload relay for **[eutectic melting alloy] [ambient compensated bimetallic] [solid state]** thermal overload units.
2. When provided, control circuit transformers shall include two primary protection fuses and one secondary fuse (in the non-ground secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads. The transformer rating shall be fully visible from the front when the unit door is opened.
3. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.
4. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field convertible to normally open or normally closed operation.
5. NEMA/EEMAC Size 1-4 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) shall connect directly to the starter

terminals without the use of interposing terminals. Larger starters shall be arranged so that power wiring may exit through the bottom of the starter cubical without entering the vertical wireway.

6. **[Units provided in MCCs rated for arc resistance shall be fitted with 12 gauge steel doors and control station panels. Each unit shall have additional door hinges, arc latches, and fasteners that have been tested and provide additional rigidity and support in the event of an internal arc fault.]**

B. Terminal Blocks

1. When Type B wiring is specified, all starter units shall be provided with unit control terminal blocks.
2. Terminal blocks shall be the pull-apart type with a minimum rating of 250 volt and 10 amps. All current carrying parts shall be tin plated. Terminals shall be accessible from inside the unit when the unit door is opened. Terminal blocks shall be DIN rail mounted with the stationary portion of the block secured to the unit bottom plate. The stationary portion shall be used for factory connections, and shall remain attached to the unit when removed. The terminals used for field connections shall face forward so they can be wired without removing the unit or any of its components.
3. When Type C wiring is specified, all starter units shall be provided with unit control terminal blocks as described for Type B wiring along with power terminal blocks for size 1-3 units. An additional set of terminal blocks shall be provided in a terminal compartment located in each section. These terminal blocks shall be pre-wired to the unit terminals so that all field control connections can be made at the terminal compartments.

C. Nameplates

1. Shall be engraved phenolic nameplates for each MCC and unit compartment. Shall be gray background with white letters, measuring a minimum of 1.5 in (38 mm) H x 6.25 in (159 mm) W total outside dimensions.

D. Pilot Device Panel

1. Each combination starter unit shall be proved with a hinged/removable control station plate, which can accommodate up to five 22 mm pilot devices or three 30 mm pilot devices. **[The control station plate can be deleted if no local unit pilot devices are required.]**

2.10 SIX INCH UNIT CONSTRUCTION

A. Units with circuit breaker disconnects through 250 A frame and fusible switch disconnects through 100 A shall connect to the vertical bus through a spring-reinforced, stab-on connector. Stabs on all plug-on units shall be cable connected to the unit disconnect. Six-inch fusible units shall accept Class J fuses only.

B. All conducting parts on the line side of the unit disconnect shall be shrouded by a suitable insulating material.

C. Unit mounting shelves shall include hanger brackets to support the unit weight during installation and removal. All six inch plug-on units shall be installable without the assistance of a camming device so as to allow maximum accessibility with the unit installed.

D. A lever handle operator must be provided on each disconnect. With the unit stabs engaged into the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit disconnect with clear indication of the disconnects status. All circuit breaker operators shall include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door.

1. A mechanical interlock shall prevent an operator from opening the unit door when

the disconnect is in the ON position. Another mechanical interlock shall prevent an operator from placing the disconnect in the ON position while the door is open. It shall be possible for authorized personnel to defeat these interlocks.

2. A non-defeatable interlock shall be provided between the handle operator and the structure to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position. The plug-on unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors.

E. Provisions shall be made for locking all disconnects in the OFF position with up to three padlocks.

F. Handle mechanisms shall be located on the bottom left side of the unit and operate horizontally to encourage operators to stand to the left of the unit being switched.

G. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully-compartmentalized design.

H. Up to a maximum of twelve six inch units can be installed per vertical section without placement restrictions in new or existing applications.

2.11 COMPONENTS FOR SIX INCH UNITS

A. Six Inch Combination Starters

1. All six inch combination starters shall use a unit disconnect as described in specification 2.10. All starters shall use **[NEMA/EEMAC] [IEC]**-rated contactors. Starter units shall be provided with a 3-pole, external manual reset, overload relay for **[eutectic melting alloy (NEMA rated units only)] [solid state (NEMA rated units only)] [ambient compensated bi-metal (application-rated units)]** motor overload protection.

2. When provided, control circuit transformers shall include two primary protection fuses and one secondary fuse (in the non-ground secondary conductor.) The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads.

3. When a unit control circuit transformer is not provided, the disconnect shall include an electrical interlock for disconnection of externally powered control circuits.

4. Auxiliary control circuit interlocks shall be provided where indicated. For NEMA rated starters, auxiliary interlocks shall be field convertible to normally open or normally closed operation.

5. NEMA/EEMAC Size 1 starters shall be mounted directly adjacent to the wireway so that power wiring (motor leads) will connect directly to the starter terminals.

B. Terminal Blocks for Six Inch Units

1. All starter units shall be provided with unit control terminal blocks.

2. Terminal blocks shall be pull-apart type, 250 V, and rated for 10 amperes. All current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The stationary portion of the terminal block shall be used for factory connections and will remain attached to the unit when the portion used for field connections is removed. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components.

C. Nameplates

1. Engraved phenolic nameplates shall be provided for each MCC and unit compartment. Each nameplate shall have a gray background, white lettering, and measure a minimum of 1.5 in H x 6.25 in W (38 mm H x 150 mm W) total outside dimensions.

D. Pilot Device Control Panel

1. Each unit to be provided with a control panel for up to a maximum of four pilot devices. **[Pilot device control panel can be deleted if no local unit pilot devices are required.]** Control panel to be removable by loosening two semi-captive fasteners for customer access.

2.12 ADJUSTABLE FREQUENCY AC DRIVE UNIT CONSTRUCTION

A. The AC drive controller unit shall be a combination disconnect-drive MCC style unit. The input **[circuit breaker] [fusible switch]** shall provide NEC required branch circuit protection. The branch circuit protection shall have an external operator. The adjustable frequency drives shall be **[variable torque] [constant torque]** AC drives. Wiring between the AC drive and the disconnect shall not be disturbed when removing or installing the AC drive controller unit from the MCC.

B. Units should be of modular construction so that it is possible to readily interchange units of the same size without modifications to the MCC structure.

C. All conducting parts on the line side of the unit disconnect shall be isolated to prevent accidental contact with those parts.

D. AC drive controller units up to 50 hp variable torque shall be plug-on units which connect to the vertical bus through a spring-reinforced, stab-on connector. Units larger than 50 hp variable torque shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

E. All AC drive controller unit interior mounting panels shall be white for better visibility.

F. A disconnect operator shall be provided per specification 2.08 D.

G. All plug-on AC drive controller units shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors engage/release.

H. All AC drive controller units shall be provided with unit control terminal blocks for use in terminating field wiring. Terminal blocks shall be pull-apart type, 250 V, and rated for 10 A. All current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The stationary portion of the terminal block shall be used for factory connections and will remain attached to the unit when the portion used for field connections is removed. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components.

I. The AC drive controller unit shall incorporate a self-contained, air-based cooling system. Any air exhaust vents shall be louvered to help direct air flow away from personnel operating the AC drive controller unit. Any fans, ductwork, or filters shall be easily accessible for maintenance.

J. The AC drive controller unit cooling system shall be sized to cool the drive regardless of mounting location within the MCC. The AC drive controller unit shall not be restricted to a specific location in the MCC.

K. An internal overtemperature trip shall be provided to detect cooling system failure or blockage. Upon occurrence of an overtemperature trip, the cooling system fans shall continue running to provide a rapid cool down.

L. Power for the cooling system shall be provided internal to the AC drive controller unit by use of a control power transformer that includes two primary fuses and one secondary fuse (in the non-ground secondary conductor).

M. Electrical Ratings

1. The AC drive controller unit shall be designed to operate from an input voltage of **[208] [240] [480] [600]** Vac, + or -10%.
2. The AC drive controller unit shall operate from an input voltage frequency range of 57–63 Hz.
3. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.

4. The efficiency of the AC drive at 100% speed and load shall not be less than 96%.
5. The variable torque overtorque capacity shall be 130% for 1 minute. **[The constant torque overtorque capacity shall be 170% for 1 minute.]**
6. The output carrier frequency of the AC drive shall be selectable between 1 kHz and 16 kHz, depending on inverter rating for low noise operation. The output carrier frequency of the AC drive shall be randomly modulated to avoid resonance.
7. All AC drive controller unit feeder equipment, including conductors, lugs, disconnects, contactors, etc., shall be sized per NEC Article 430 for the AC drive input current rating. An impedance range corresponding to a 22,000 to 100,000 A fault availability level shall be assumed for the input current rating.

N. Protection
1. The AC drive controller unit shall be protected against fault currents up to and including 100,000 A rms symmetrical at 480 Vac and shall be UL 845 listed as verification.
2. Upon power-up, the AC drive shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power, and the pre-charge circuit.
3. The AC drive controller unit shall be protected against short circuits between output phases, between output phases and ground, on the internal power supplies, and on the logic and analog outputs.
4. The AC drive controller unit shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds (12 cycles). The AC drive shall have the user-defined option of frequency fold-back to increase the duration of the power-loss ride-through.
5. The AC drive will have a selectable ride-through function which will allow the logic to maintain control for a minimum of one second (60 cycles) without faulting.
6. For a fault condition other than a ground fault, short circuit, or internal fault, an auto restart function shall provide restart attempts for a period of 5 minutes and up to an unlimited amount time depending on setting. The restart attempts shall be separated by increasingly longer waiting periods to allow the condition to be cleared.
7. The deceleration mode of the AC drive shall be programmable. The stop modes shall include free-wheel stop, ramp stop, fast stop, and DC injection braking.
8. Upon loss of the analog process follower reference signal, the AC drive shall be programmable to fault and freewheel stop, ramp stop, fast stop, stop without trip, automatically restart, run at last speed, or maintain a user-defined low speed setting.
9. The AC drive shall have solid-state I^2t protection that is UL Listed, meets UL 508C as a Class 10 overload protection, and meets IEC 60947. The minimum adjustment range shall be from 25 to 150% of the nominal current rating of the AC drive controller unit.
10. The AC drive shall have three skip frequency ranges with hysteresis adjustment that can each be programmed independently, back-to-back, or overlapping.
11. The AC drive shall be include an adjustable thermal alarm which can be assigned to a relay or logic output to indicate the drive temperature has reached the thermal alarm setting.

O. Adjustment and Configuration

1. The AC drive shall have a user selectable Auto Tune feature. The Auto Tune will automatically send motor-rated current to the connected motor and store the resulting resistance data into memory. The AC drive will automatically optimize the operating characteristics according to the stored data.
2. The AC drive motor and control parameters will be factory preset to operate most common applications. Necessary adjustments for factory supplied unit operator controls and sequencing shall be pre-programmed and tested by the manufacturer.
3. A choice of three types of acceleration and deceleration ramps will be available in the AC drive software—linear, S curve, and U curve—as well as custom.
4. The acceleration and deceleration ramp times shall be adjustable from 0.01 to 6000 seconds.
5. The volts per frequency ratios shall be user selectable to meet variable torque loads, normal, and high torque machine applications.
6. The memory shall retain and record run status and fault type of the past eight faults for operator review.
7. The software shall have an energy saving function that will optimize the energy consumed. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.
8. Slip compensations shall be a software-enabled function.
9. The AC drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current will be adjustable between 10–110% of rated current and available from 0.1–30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50% of the nameplate current of the motor.
10. Sequencing logic will coordinate the engage and release thresholds and time delays for the sequencing of the AC drive output, mechanical actuation, and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

P. Graphic Display Terminal Interface

1. The graphic display terminal shall provide 8 lines of 240 by 160 pixels in plain English to control, adjust, and configure the AC drive including all electrical values, bar charts, configuration parameters, I/O assignment, application and activity function access, faults, local control, adjustment storage, self-test, and diagnostics. There will be a standard selection of six additional languages built in to the operating software as standard.
2. The AC drive model number, torque type, software revision number, horsepower, output current, motor frequency, and motor voltage shall all be listed on the drive identification display as viewed on the graphic display terminal.
3. The graphic display shall be able to indicate one, two, or five digital values, or up to two values by bar graph. As a minimum, the selectable display values shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference, and machine speed.
4. The graphic display terminal will consist of programmable function keys. The functions will allow both operating commands and programming options to be preset by the operator.
5. The graphic display terminal shall offer levels of settings from simple start-up to advanced user menus consisting of parameter setting, I/O map, fault history, and

drive configuration. Password protection shall be available to limit unauthorized access to various levels of the menus.

6. The navigation wheel shall provide the ability to scroll through menus and screens, select or activate functions, or increase the value of a selected parameter.
7. An escape key shall allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function will also return to a previous menu display.
8. A RUN key and a STOP key shall command normal starting and stopping as programmed when the AC drive is in keypad control mode. The STOP key shall be active in all control modes.
9. A **[Windows® based personal computer] [serial communication link] [detachable graphic terminal display]** user interface shall be available.
10. The keypad shall store up to four user configuration programs in nonvolatile memory. An operator shall have the ability to download a stored configuration to multiple AC drives.
11. The operator interface shall be MCC door-mounted on the AC drive controller unit for ease of access and increased visibility**. [STAGE 1: MCCs rated for arc resistance shall have an external communication port mounted on the door for connection to a remote keypad to minimize arc blast exhaust] [STAGE 2: MCCs rated for arc resistance shall have a steel-reinforced keypad holder to minimize arc blast exhaust]**
12. All door-mounted controls shall be NEMA/EEMAC Type 12 rated.

Q. Control

1. Pilot devices shall be industrial rated **[22mm] [30mm]** type control operators and used independently of the keypad display. Software assignments for control inputs and outputs to operate factory-supplied controls shall be pre-configured from the factory. The following basic controls shall be provided:
   [HAND-OFF-AUTO selector switch - The HAND mode shall allow manual operation of start, stop, and speed control. The AC drive shall start when the control operation is in the HAND mode. A door-mounted, manual-speed potentiometer shall be used to control speed in the HAND mode. The AC drive shall run at the low speed setting or higher as required by the position of the manual-speed potentiometer. This mode shall function as 2-wire control and automatically restart after a power outage or auto restart after a fault. The OFF position of the control operation shall stop the AC drive and prevent it from restarting. The AUTO (automatic) mode shall receive an [auto start contact] [serial link command] to control starting and stopping of the AC drive. This contact shall also start and stop bypass (if used) when both the automatic and bypass modes of operation are selected. Speed control shall be from a customer supplied [4–20 mAdc] [serial link communication] signal.]
   [START-STOP pushbuttons—START/STOP pushbuttons shall provide 3-wire start/stop control.]
   [POWER On pilot light, red]
   [FAULT pilot light, yellow, push-to-test]
   [RUN pilot light, green, push-to-test]
   [STOPPED pilot light, red, push-to-test]
   [HAND/AUTO pilot lights, yellow, push-to-test]
   NOTE: Additional controls can be found on the equipment electrical diagrams.
2. 2-wire or 3-wire control strategy shall be defined within the software.
3. The control power for the digital inputs and outputs shall be 24 Vdc.
4. The internal power supply incorporates an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs shall be current limited and not be damaged if shorted or if excess current is pulled.

5. All logic connections shall be furnished on pull-apart terminal strips.
6. There will be (2) two software assignable analog inputs with interference filtering. The analog inputs will be software selectable and consisting of user defined configurations: x-y mA or x-y V.
7. There will be five software assignable logic inputs that will be selected and assigned in the software. The selection of assignments shall consist of forward, reverse, jog, plus/minus speed (2 inputs required), setpoint memory, preset speeds (up to 8 inputs), auto/manual control, controlled stop, terminal or keypad control, output contactor (2 inputs required), motor switching, and fault reset.
8. There will be two software assignable analog outputs with interference filtering. The analog outputs can be selected and assigned in the software. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power, torque, voltage, and thermal state. The output signal will be user-defined configurations: x-y mA or x-y V.
9. Two voltage-free Form C relay output contacts shall be provided. One of the contacts will indicate AC drive fault status. The other contact will be user assignable.

Note to Specification Writer: Items 10 and 11 are optional network communications specifications.

10. **[Drives shall include network communication interface for data acquisition only over [Modbus] [Modbus Plus] [Ethernet (Modbus TCP)] [DeviceNet] [PROFIBUS DP]. Drive control and speed control via PLC hardwired I/O shall include:]**

    [PLC Analog output (4–20 mA) speed reference signal]

    [PLC Analog input (4–20 mA) speed feedback signal]

    [PLC digital output drive start control] [PLC digital outputs for drive preset speed control]

    [PLC digital input drive run (Run =1)]

    [PLC digital input drive fault (Fault = 1)]

11. **[Drives shall include network communication interface for control and data acquisition over [Modbus] [Modbus Plus] [Ethernet (Modbus TCP)] [DeviceNet] [PROFIBUS DP] [Ethernet IP].**

    [At a minimum, drive units shall allow configuration of these parameters:]

    — [Motor Frequency]

    — [Motor Voltage]

    — [Ramp Profiles]

    — [I/O Assignments]

    — [Current Limitation]]

    [Drive units shall be capable of making these adjustments:]

    — [Speed Range]

    — [Ramp Time]

    — [Thermal Protection]

    [Drive units shall allow control of these parameters:]

    — [Start/Stop]

    — [Braking]

    — [Frequency Reference]

    — [Fault Resets]

R. Optional Isolation/Bypass Contactors

1. As a UL Listed option, the AC drive controller unit shall include **[NEMA rated isolation and bypass contactors packaged as a separate MCC unit with steel barriers segregating the AC drive from the bypass starter][IEC rated isolation and bypass contactors integrated with the AC drive as one MCC unit to reduce space]**.
2. The isolation and bypass contactors shall be mechanically and electrically interlocked complete with a Class 10 thermal overload relay, disconnect interlocked with the door, control circuit transformer, AFC/OFF/BYPASS switch, and BYPASS RUN and AFC RUN lights.
3. The operator shall have full control of the bypass starter by operation of the door-mounted selector switch.
4. When the drive is supplied with a HAND-OFF-AUTO selector switch, the AUTO mode shall also control the run/stop of the bypass operation.

S. Optional Harmonic Provisions

1. A harmonic distortion analysis shall be performed and priced as a separate line item by the AC drive manufacturer based upon system documentation supplied by the contractor. The documentation shall consist of one-line diagrams, distribution transformer information (kVA, %Z, and X/R ratio), and emergency standby generator performance specifications. The harmonic distortion analysis report shall be part of the approval drawing process, submitted to the engineer for approval. If the calculations determine that harmonic distortion values are higher than the voltage and current values specified in IEEE 519-1992, the drive manufacturer shall provide line reactors of sufficient percent impedance to meet the IEEE specified values. The line reactor shall be ventilated in the MCC and shall be completely factory wired and tested with the AC drive controller unit.
2. A **[3% impedance] [5% impedance]** line reactor shall be provided that is completely factory wired and tested with the AC drive controller unit.
3. An active harmonic filter shall be provided to perform electronic cancellation of load produced harmonic currents such that the upstream power harmonic current and voltage are reduced below the IEEE 519-1992 guidelines for load demand and voltage distortion limits. Filter shall be Square D® brand Accusine or equivalent. Performance of the filter shall be independent of the impedance of the power source: AC lines or back-up generator. All necessary current transducers, reactors, and operator interfaces shall be supplied with the MCC. A factory certified start-up technician shall be used to start up each harmonic filter to achieve optimum system performance.

T. Optional Load Filters

As a UL Listed option, the AC drive controller unit shall include a motor protection filter unit designed to limit peak voltages and reduce electrical stress on the motor insulation. This option shall be required for motor lead lengths above 150 ft. (50 m). The filter unit shall be ventilated to limit heat build up within the MCC.

2.13 Solid-State Reduced-Voltage Starter Unit Construction

A. The soft start controller unit shall be a combination disconnect/soft starter, MCC-style unit. The input **[circuit breaker][fusible switch]** shall provide NEC required branch circuit protection. The branch circuit protection shall have an external operator. Wiring between the soft starter and the disconnect shall not be disturbed when removing or installing the soft start controller unit from the MCC. Units shall be of modular construction so that units of the same size can be interchanged without modifications to the MCC structure.

B. All conducting parts on the line side of the unit disconnect shall be isolated to prevent accidental contact with those parts.

C. Soft start controller units rated for standard duty (up to 156 A) shall be plug-on units which connect to the vertical bus through a spring-reinforced stab-on connector. Units rated higher than 156 A shall be connected directly to the main horizontal bus with appropriately sized cable or riser bus.

D. All soft start controller unit interior mounting panels shall be white for better interior visibility.

E. A disconnect operator shall be provided per specification 2.08 D.

F. All plug-on soft start controller units shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors engage/release.

G. Handle mechanisms shall be located on the left side to encourage operators to stand to the left of the unit being switched.

H. All soft start controller units shall be provided with unit control terminal blocks for use in terminating field wiring. Terminal blocks shall be pull-apart type, 250 V, and rated for 10 A. All current-carrying parts shall be tin-plated. Terminals shall be accessible from inside the unit when the unit door is opened. The stationary portion of the terminal block shall be used for factory connections and will remain attached to the unit when the portion used for field connections is removed. The terminals used for field connections shall be accessible so they can be wired without removing the unit or any of its components.

I. The enclosure shall include a door-mounted digital keypad for adjusting the soft start parameters and viewing the motor, soft start, and fault status without opening the enclosure door.

J. A shorting contactor shall be supplied in each soft start controller unit to reduce temperature rise within the unit and MCC enclosure. The shorting contactor shall be rated to carry the motor full load current during steady state after full voltage has been applied to the motor by the soft starter.

K. Electrical Ratings

1. The soft start controller unit shall be designed to operate from an input voltage between -10% and +10% of nominal voltage rating.
2. The soft start controller unit shall operate from an input voltage frequency range of +/-5%.
3. The soft starter shall be capable of supplying 350% of rated full load current for 20 seconds at the maximum ambient temperature.
4. All soft start controller unit power and control devices shall be rated for:

   [Standard Duty capable of 3 evenly spaced starts per hour at 300% of full rated current for 20 seconds per start without tripping.] [Severe Duty capable of 3 evenly spaced starts per hour at 350% of full rated current for 24 seconds per start without tripping.]
5. The silicon-controlled rectifiers (SCRs) shall have a minimum peak inverse voltage (PIV) rating of 1800 Vac. Lower rated SCRs with protection by metal oxide varistors (MOVs) are not acceptable.

L. Protection

1. A microprocessor-based thermal protection system shall be included that continuously calculates the temperature rise of the motor and soft starter and provides:

   A motor overload pre-alarm that indicates by relay contact or logic output that the motor windings have exceeded 110% of their rated temperature rise. This function shall be for alarm only.

   A motor overload fault will stop the motor if the windings have exceeded 125% of their rated temperature rise.

An electronic circuit with a time-constant adjustable to the motor's thermal cooling time-constant that ensures memorization of the thermal state even if power is removed from the soft starter.

2. The soft starter shall provide line and motor phase loss, phase reversal, underload, stall, and jam protection.
3. The soft start controller unit shall include a shorting contactor which closes after full voltage has been applied to the motor by the soft starter to reduce the current carrying duty on the SCRs. The integral protective features shall be active even when the shorting contactor is used to bypass the SCRs during steady state operation.
4. All units and options shall be constructed with protection provisions to pass UL 845 short circuit testing criteria at a minimum of 100,000 A short circuit current.
5. Diagnostic faults and soft start status shall be displayed on the door-mounted keypad after a fault condition.
6. The motor must be automatically protected from solid state component failure by one of the following means:

   [Shunt trip coil to trip disconnect in the event of a soft start fault condition, including a shorted SCR.]

   [Isolation contactor that opens when the motor is stopped or when the controller detects a fault condition including a shorted SCR.]

M. Adjustments and Configurations

1. All programming/configuration devices, display units, and field control wiring terminals shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments is prohibited.
2. Digital indication shall provide, as a minimum, the following conditions:

   Soft starter status—ready, starting/stopping, run

   Motor status—current, torque, thermal state, power factor, operating time, power in kW

   Fault status—motor thermal overload, soft starter thermal fault, loss of line or motor phase, line frequency fault, low line voltage fault, locked rotor fault, motor underload, maximum start time exceeded, external fault, serial communication fault, line phase reversal fault, motor overcurrent fault
3. The starter shall be preset to the following for operation without adjustment in most applications:

   Linear (torque-controlled) acceleration ramp of 10 seconds

   Current limitation to 350% of the motor full load current rating

   Class 10 overload protection

   Motor current preset per NEC / NFPA 70 table 430.150 for standard hp motors
4. A digital keypad shall be used to configure the following operating parameters as required:

   Motor full load amps adjustable from 40 to 100% of the controller's rating

   Current limitation on starting adjustable from 200 to 700% of the motor current rating, not to exceed 350% of the soft start rating

   Voltage ramp adjustable from 1 to 60 seconds

   Initial voltage adjustable from 10 to 50% of nominal motor torque

   Maximum start time adjustable from 1 to 250 seconds

   Voltage boost duration adjustable from 0.1 to 1 second

   Selection of freewheel or soft stop

Linear (torque-controlled) deceleration ramp time adjustable from 1 to 60 seconds

Threshold to change to freewheel following a soft stop from 0 to 10% of the nominal motor torque

Selection of Class 10, 20, or 30 motor thermal overload protection

5. A digital keypad shall be used configure the following controller parameters as required:

   Assignment of soft start inputs and outputs

   Activation of phase reversal protection

   Reset of motor thermal state

   Return to factory parameter settings

   Activation of self test mode

   Indication of elapsed time in hours of starting, running and stopping

6. Output relays shall provide the following status indications:

   One Form A (N.O.) minimum for indication of trip

   One Form A (N.O.) for indication that soft start is running

7. Additional inputs and outputs shall be available to provide the following status indications:

   Two assignable control inputs for the following functions: external fault input, disable serial link control, 2nd set of parameters, or general fault reset

8. Relay and I/O functions listed above must be isolated with respect to common.

N. Control Options

1. The soft starter's control circuit shall be fed from a fused line supply and be completely independent of the power circuit and separate from relay control logic.
2. The peripheral soft starter control circuitry shall be operated from a control power transformer included within the enclosure.
3. Operator devices shall be door-mounted and shall be (choose all that apply):

   Black START and red STOP push buttons

   Three position H-O-A switch which provides for manual (HAND) start or remote signal

   (AUTO) start from user-supplied relay contacts

   Three position FORWARD/OFF/REVERSE selector switch mounted on the door control island (available with reversing starter only)

   Red RUN pilot light illuminated whenever the soft starter is provided a run command and no fault condition is present

   Green OFF pilot light illuminated whenever the soft starter is supplied with control power and no run command is present

Note to Specification Writer: Item P is optional; delete if not needed.

P. [Full Voltage Emergency Starter]

1. [The soft start controller unit shall include full voltage starting capability to start and control the motor instead of the reduced voltage soft start method of starting the motor.]

2. [The full voltage emergency starter shall be UL Listed and shall include an IEC rated contactor capable of carrying the motor inrush and motor full load current.]

3. [A door-mounted BYPASS/NORMAL selector switch shall be provided to enable the user to manually select the motor starting method. NORMAL mode provides a reduced voltage start using the soft starter. In BYPASS

mode, the soft starter will be left inactive and the motor will be started using an across-the-line full voltage starting method.]

4. **[An overload provision independent of the soft starter shall be provided to protect the motor in the BYPASS mode.]**
5. **[The full voltage emergency starter components shall be integrated inside the soft start controller unit and shall be fully tested by the MCC manufacturer.]**

2.14 General Communication Cabling

A. The MCC shall employ a pre-engineered communication cabling system to interconnect units within the MCC.

B. Network cabling shall be routed through the lower horizontal wireway to isolate the network from the horizontal bussing routed through the top.

C. The full-depth vertical wireway serves to separate communications from power cabling to prevent noise interference on the network cable.

D. The communication cabling installation shall meet Class 2 wiring practices under the provisions of NEC articles 725 and 800.

E. Provisions for appropriate terminators and grounding shall be provided.

F. Addition, removal, or rearrangement of units shall not interrupt the trunk line and shall not affect the cabling of other units attached to the trunk line.

G. Cable assemblies will use 5-pole Micro-style connectors with a single keyway and will comply with SAE-H1738-2 specifications.

H. Connectors are to be epoxy-coated for a 500-hour salt-spray test per Mil-Std 202F.

I. Cable coupler design shall include a vibration-resistant ratchet to prevent loosening.

J. The system will be constructed of molded PVC material.

2.15 Modbus® Communication Cabling

A. The Modbus cabling system will be UL 498 Listed.

B. An extended ground pin shall ensure first make/last break ground connections.

C. The cabling system shall consist of individual trunk line segments in each MCC section. A trunk/drop topology will be used. Trunk line segments will be routed from the lower wireway into each vertical section. The trunkline for sections containing plug-on vertical bus shall have six taps spaced 12 in. apart. Unused tee connectors will be capped at the factory.

D. A 36-in. (915 mm) “pigtail” cable shall connect the communication device in each MCC unit to the trunk cable via a pre-engineered tap. One end of the pigtail cable will terminate in a Micro-style connector and will be attached to the trunk. The other end will terminate at the communication device in the MCC unit.

2.16 Ethernet (Modbus TCP) Communication Cabling

A. The Ethernet (Modbus TCP) communications network shall be configured in a star topology.

B. The cabling system shall consist of multiple, custom-length Ethernet patch cables that each connect a single network device to a central Ethernet switch unit located in the MCC.

C. Ethernet switches located in the MCC shall be Connexium, Hirschmann, or approved equal.

2.17 DeviceNet™ Communication Cabling

A. The DeviceNet cabling system will be ODVA rated with a trunkline-dropline topology.

B. Control power shall be provided through individual unit transformers that are separate from the network to reduce network power demand. This will allow devices to operate independently of the network power supply.

C. Sectioned cabinets shall have six pre-molded trunklines with tees. Full length cabinets shall have one trunkline with a tee. A tee at the bottom of each section shall provide the means of connection to the next section with a pre-molded section of cable.

D. A 36-in. (915 mm) “pigtail” cable shall connect the tee in the dropline to the DeviceNet device located in the MCC unit.

2.18 CANopen Communication Cabling

A. The CANopen cabling system will be configured in a trunkline-dropline topology.

B. Control power shall be provided through individual unit transformers that are separate from the network to reduce network power demand. This will allow devices to operate independently of the network power supply.

C. Sectioned cabinets shall have six pre-molded trunklines with tees. Full length cabinets shall have one trunkline with a tee. A tee at the bottom of each section shall provide the means of connection to the next section with a pre-molded section of cable.

D. A 36-in. (915 mm) “pigtail” cable shall connect the tee in the dropline to the CANopen device located in the MCC unit.

2.19 PROFIBUS DP Communication Cabling

A. The PROFIBUS DP cabling system shall consist of individual trunk line segments in each MCC section. A trunkline-dropline topology will be used. Trunk line segments will be routed from the lower wireway into each vertical section. The trunkline for sections containing plug-on vertical bus shall have six taps spaced 12 in. apart. Unused tee connectors will be capped at the factory.

B. Sectioned cabinets shall have six pre-molded trunklines with tees. Full length cabinets shall have one trunkline with a tee. A tee at the bottom of each section shall provide the means of connection to the next section with a pre-molded section of cable.

C. A 36-in. (915 mm) “pigtail” cable shall connect the tee in the dropline to the PROFIBUS DP device located in the MCC unit.

3. Each device shall be configured and addressed to correspond with software settings.

4. A Read/Write test shall be performed prior to shipment on all network devices including, but not limited to, Overloads, Drives, and Soft Starters.

5. Testing shall be designed to verify system operation and shall include these verifications as a minimum:

Drawings and Bill of Materials

I/O addressing

Correct device operation by I/O address

Host Communications

Control Network Interface

6. Markings/Labels include:

Instructional type

Underwriters Laboratory (UL)/Canadian Standards Association (CSA)

Inspector's stamps

7. The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

2.20 QUALITY CONTROL

A. The entire MCC shall go through a quality inspection before shipment. This inspection will include:

1. Physical Inspection of:
    a. Structure.
    b. Electrical conductors, including:
        1) bussing.
        2) general wiring.
        3) units.
2. Electrical Tests
    a. General electrical tests include:
        1) power circuit phasing.
        2) control circuit wiring.
        3) instrument transformers.
        4) meters.
        5) ground fault system.
        6) device electrical operation.
    b. AC dielectric tests shall be performed on the power circuit.
3. Markings/Labels, include:
    a. instructional type.
    b. Underwriters Laboratory (UL)/Canadian Standards Association (CSA).
    c. inspector's stamps.
4. Each device shall be configured and addressed to correspond with software settings.
5. A Read/Write test shall be performed prior to shipment on all network devices including, but not limited to, Overloads, Drives, and Soft Starters.
6. Testing shall be designed to verify system operation and shall include these verifications as a minimum:

    Drawings and Bill of Materials

    I/O addressing

    Correct device operation by I/O address

    Host Communications

    Control Network Interface
7. The manufacturer shall use integral quality control checks throughout the manufacturing process to ensure that the MCC meets operating specifications.

PART 3 EXECUTION

3.01 LOCATION

A. Motor control centers are not to be placed in hazardous locations. The area chosen shall be well ventilated and totally free from humidity, dust and dirt. The temperature of the area shall be no less than 0° C (32° F) and no greater than 40° C (104° F). For indoor locations, protection must be provided to prevent moisture entering the enclosure.

B. Motor control centers shall be located in an area with a minimum of 3 ft (915 mm) of free space in front of front-of-board construction. An additional 3 ft (915 mm) should be allowed in the rear of back-to-back construction. This free space will give adequate room to remove and install units. A minimum of 0.5 in (13 mm) space should be provided between the back of front-of-board MCCs and a wall, 6 in (152 mm) required for damp locations).

C. The motor control centers shall be assembled in the factory on a smooth level surface so that all sections are properly aligned. A similar smooth and level surface

shall be provided for installation. An uneven foundation will cause misalignment of shipping blocks, units, and doors. The surface under a MCC shall be of a non-combustible material unless bottom plates are installed in each vertical section.

D. [MCCs rated for arc resistance shall have a minimum of 28.5" of clearance above the top of the MCC to allow for exhausting of arc fault energy.]

3.02 PACKING/SHIPPING

A. The MCC shall be separated into shipping blocks no more than three vertical sections each. Shipping blocks shall be shipped on their sides to permit easier handling at the jobsite. Each shipping block shall include a removable lifting angle, which will allow an easy means of attaching an overhead crane or other suitable lifting equipment.

3.03 STORAGE

A. If the MCC cannot be placed into service reasonably soon after its receipt, store it in a clean, dry and ventilated building free from temperature extremes. Acceptable storage temperatures are from 0° C (32° F) to 40° C (104° F).

3.04 WARRANTY

A. The MCC shall be warranted to be free from defects in materials and workmanship for a period of eighteen (18) months from date of invoice from manufacturer or authorized sales channel.

END OF SECTION