

SECTION 16482A

MOTOR CONTROL CENTERS – LOW VOLTAGE (FREEDOM)

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install the motor control centers as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

- A. Section 16475 – Circuit Breakers and Fusible Switches
- B. Section 16481 – Motor Starters and Overload Relays – Low Voltage
- C. Section 16483A, B, C, & D – Adjustable Frequency Drives
- D. Section 16671A – Transient Voltage Surge Suppression
- E. Section 16901 – Microprocessor-Based Metering Equipment
- F. Section 16902 – Electric Control Devices
- G. Section 16903 – Protective Relays
- H. Section 16906 – Logic Controllers
- I. Section 16911 – Power Management Systems and Products

1.03 REFERENCES

- A. The Motor Control Centers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845.

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Engineer:
 - 1. Master drawing index
 - 2. Front view elevation
 - 3. Floor plan
 - 4. Top view
 - 5. Unit wiring diagrams
 - 6. Nameplate schedule
 - 7. Starter and component schedule
 - 8. Conduit entry/exit locations
 - 9. Assembly ratings including:

- a. Short-circuit rating
 - b. Voltage
 - c. Continuous current
10. Major component ratings including:
- a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
11. Cable terminal sizes
12. Product data sheets
- A. Where applicable the following information shall be submitted to the Engineer:
1. Busway connection
 2. Connection details between close-coupled assemblies
 3. Key interlock scheme drawing and sequence of operations

1.02 SUBMITTALS – FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes:
1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
 2. Unit wiring diagrams
 3. Certified production test reports
 4. Installation information
 5. Seismic certification and equipment anchorage details as specified

1.03 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- D. *Provide Seismic tested equipment as follows:
1. The equipment and major components shall be suitable for and certified by actual seismic testing to meet all applicable seismic requirements of the [latest International Building Code (IBC)] [latest California Building Code (CBC) with OSHPD Amendments]. [The equipment shall have OSHPD Special Seismic Certification (OSP) Pre-Approval.]

* Note to Spec. Writer - Optional

2. The Project Structural Engineer will provide site specific ground motion criteria for use by the manufacturer to establish SDS values required.
3. The IP rating of the equipment shall be 1.5
4. The Structural Engineer for the Site will evaluate the SDS values published on the [Manufacturer's] [OSHPD] website to ascertain that they are "equal to" or "greater than" those required for the Project Site.
5. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
6. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed civil engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon the above criteria to verify the seismic design of the equipment.
 - a. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in above codes.
 - b. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.

1.04 REGULATORY REQUIREMENTS

- A. The motor control centers shall bear a UL label. *[Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the Engineer.]

1.05 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.06 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton
- B. * _____
- C. * _____

* Note to Spec. Writer – Optional

* Note to Spec. Writer – Insert data in blanks

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the engineer ten (10) days prior to bid date.

2.02 RATINGS

- A. The Motor Control Center(s) shall be 600-volt class suitable for operation on a three-phase, 60 Hz system. The system operating voltage and number of wires shall be as indicated on the drawings.

2.03 CONSTRUCTION

- A. Motor Control Center(s) shall be equal to Eaton type F2100 design.
- B. Structures shall be totally enclosed, dead-front, free-standing assemblies. They shall be 90 inches high and *[16 inches] [21 inches] deep for front-mounted units and 21 inches deep for back-to-back mounted units. Structures shall contain a horizontal wireway at the top *[9] [15] inches tall, isolated from the horizontal bus via metal barriers and shall be readily accessible through a hinged cover. Structures shall also contain a horizontal wireway at the bottom *[9] [3] inches tall that is open to the full rear of the structure. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.
- C. Compartments for mounting control units shall be incrementally arranged such that not more than *[six (6)] [twelve (12)] Size 1 or Size 2 starters for front-mounted only] [[eleven (11)] [twenty-three (23)] Size 1 or Size 2 starters for back-to-back] can be mounted within each vertical structure. Guide rails shall be provided.
- D. A vertical wireway with minimum of 35 square inches of cross-sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.
- E. All full voltage starter units through NEMA Size 5 and all feeder breakers through 400 Amp shall be of the draw-out type. Draw-out provisions shall include a positive guide rail system and stab shrouds to absolutely ensure alignment of stabs with the vertical bus. Draw-out units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend outside of the draw-out unit. Interior of all units shall be painted white for increased visibility. Units shall be equipped with side-mounted, positive latch pull-apart type control terminal blocks rated 600 volts. Knockouts shall be provided for the addition of future terminal blocks. In addition, a master terminal block, when Type C wiring is specified, shall be draw-out and shall be located in the *[top] [bottom] wireway, readily accessible through a hinged cover. All control wire to be *[14 gauge] [16 gauge] minimum.
- F. All draw-out units shall be secured by a spring-loaded, quarter turn, indicating type fastening device located at the top front of the unit. With the exception of the dual-mounted units, each unit compartment shall be provided with an individual front door.
- G. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access, unless the disconnect

* Note to Spec. Writer – Select one

is in the “OFF” position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. A second interlock shall be provided to prevent removal or reinsertion of the unit while in the “ON” position. Padlocking facilities shall be provided to positively lock the disconnect in the “OFF” position with up to three (3) padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.

2.04 BUS

- A. Each structure shall contain a main horizontal *[tin-plated copper] [silver-plated copper] bus, with minimum ampacity of *[600 amperes] [800 amperes] [1200 amperes] [1600 amperes] [2000 amperes] [2500 amperes] [3200 amperes] or as shown on the drawings. The horizontal bus shall be rated at *[65] [50] degrees C temperature rise over a 40 degrees C ambient in compliance with UL standards. Vertical bus feeding unit compartments shall be tin-plated copper and shall be securely bolted to the horizontal main bus. All joints shall be front-accessible for ease of maintenance. The vertical bus shall have a minimum rating of [600 amperes for back-to-back mounted units] [600 amperes] [800 amperes] [1200 amperes] or as shown on the drawings. Both vertical and horizontal bus shall be fully rated; but shall not be tapered. Tapering of vertical bus via a center feed is not acceptable. Both top and bottom of this type bus must be individually fully rated.
- B. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical buses to prevent any fault-generated gases to pass from one phase to another. The vertical bus shall include a shutter mechanism that will allow the unit stabs to engage the vertical bus every 6 inches and provide complete isolation of the vertical bus when a unit is removed.

--*OR--

- B. Isolation of the vertical bus compartment from the unit compartment shall be by means of a full height insulating barrier. This barrier shall be a single sheet of glass-reinforced polyester with cutouts to allow the unit stabs to engage the vertical bus every 6 inches. Provide snap-in covers for all unused openings.
- C. Buses shall be braced for *[65,000] [100,000] amperes RMS symmetrical.
- D. A *[tin-plated] [silver-plated] copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the motor control center. The ground bus shall be located in the *[top] [bottom] horizontal wireway.
- E. *Each structure shall contain tin-plated vertical ground bus rated 300 amperes. The vertical ground bus shall be directly connected to the horizontal ground bus via a tin-plated copper connector. Units shall connect to the vertical bus via a tin-plated copper stab.

2.05 WIRING/TERMINATIONS

* Note to Spec. Writer – Select one

* Note to Spec. Writer – Optional

- A. Wiring shall be NEMA Class *[I] [II], Type *[A] [B] [C].

2.06 MOTOR CONTROLLERS

Note to spec. Writer:

two classes of combination motor starters are outlined below.

Select the first paragraph 2.06 a. For circuit breaker type combination starters.

Select the second paragraph 2.06 a. For fusible type starters combination starters.

- A. Combination starter units shall be full-voltage non-reversing, unless otherwise shown, and shall utilize Eaton type HMCP Motor Circuit Protectors.
1. Each combination unit shall be rated *[65,000] [100,000] AIC symmetrical at 480 Volt. The HMCP shall provide adjustable magnetic protection and be adjustable to 1700% motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a “tripped” position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP motor circuit protectors through size 4 shall include transient override feature for motor inrush current. *[HMCP shall be used to provide IEC 947-4 Type 2 coordination to 100,000 amperes]

*OR --

- B. Combination starter units shall be full-voltage non-reversing, unless shown otherwise utilizing fusible switches.
1. Fusible switches shall be quick-make, quick-break and shall accept Class R dimension fuses and the combination shall safely interrupt 100,000 amperes. Fusible combination starters shall provide IEC 947-4 Type 2 coordination to 100,000 amperes

C. Motor Starters

1. Magnetic starters through NEMA Size 9 shall be equipped with double-break silver alloy contacts. The starter must have straight-through wiring. Each starter shall have a minimum of one (1) normally open auxiliary contact
2. Coils shall be of molded construction through NEMA Size 9. All coils to be color-coded through size 5 and permanently marked with voltage, frequency and part number
3. Overload relays shall be an ambient compensated bimetallic-type with interchangeable heaters, calibrated for 1.0 and 1.15 service factor motors. Electrically isolated normally open and normally closed contacts shall be provided on the relay. Visual trip indication shall be standard. A test trip feature shall be provided for ease of troubleshooting and shall be conveniently operable without removing components or the motor starter. Overload to have (+/-) 24% adjustability, single-phase sensitivity, isolated alarm contact, and manual or automatic reset

*OR –

* Note to Spec. Writer – Select one

* Note to Spec. Writer – Optional

3. Solid-State Overload Relay C440
 - a. Provide a solid-state overload relay for protection of the motors. The relay shall be Eaton C440 or approved equal.
 - b. The overload relay shall provide high accuracy through the use of state-of-the-art microelectronic packaging technology. The relay shall be suitable for application with NEMA Size 1 through Size 7 motor starters.
 - c. The overload relay shall be modular in design, be an integral part of a family of relays to provide a choice of levels of protection, be designed to directly replace existing electromechanical overload relays, and be listed under UL Standard 508.
 - d. The overload relay shall have the following features:
 1. Self-powered
 2. Class 10A, 10, 20, or 30 selectable tripping characteristics
 3. Manual or automatic reset
 4. Supply with [24 VDC] [24 VAC] [120 Vac] Electronic reset
 5. Reset capabilities through onboard fieldbus
 6. Selectable (On/Off) Phase loss protection. The relay shall trip in 10 seconds or less under phase loss condition
 7. Selectable (On/Off) Phase Imbalance protection. The relay shall trip in 10 seconds or less under phase imbalance condition.
 8. Visible trip indication
 9. One normally open and one normally closed isolated auxiliary contact
 10. Test button that operates the normally closed contact
 11. Test trip function that trips both the normally and normally closed contacts
 12. A current adjustment range of 5:1 or greater
 13. Embedded, selectable (On/Off)Ground fault protection shall be [supplied] [an available option]. Relay shall trip when ground fault is detected at 50% of full load ampere setting
 14. An LED that provides self-diagnostic information
 15. An LED that aids in commissioning by indicating running current is too high compared to the FLA dial
 16. [Modbus 485 RTU][Modbus 485 RTU with I/O] [DeviceNet with I/O] [Modbus TCP with I/O and webserver], [EtherNet/IP with I/O with webserver] or [Profibus DP] Communication shall be [supplied] [an available option].
 17. Additional digital Inputs and Outputs (4 in and 2 out additional) shall be [supplied] [an available option]. Inputs shall be 120 Vac, or 24 VDC, and outputs shall be discrete relay outputs
 18. Diagnostic Trip Information indicating a specific trip on either ground fault, phase loss, phase imbalance, or thermal
 19. When using any of the available fieldbus the relay shall be capable of providing the following data monitoring:
 - a. Individual Phase Currents
 - b. Average RMS Current
 - c. Thermal Capacity

* Note to Spec. Writer – Select one

- d. % Phase unbalance
- e. GF Current
- f. Line Frequency
- g. Relay settings
- h. Contactor Status

*OR –

4. Solid-State Overload Relay- C441

- a. Where indicated on the drawings, use a microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control, diagnostics and monitoring of the motors. The OLR shall be Eaton type C441 (Motor Insight) overload and monitoring relay. The OLR shall meet UL 1053, UL 508, CUL and CSA, and IEC standards
- b. The OLR shall not require external current transformers for motor applications from 1 to 90 amperes FLA. Where larger motors are involved, external current transformers shall be used
- c. The OLR shall be rated for application of 660VAC and less.
- d. The OLR shall have the following motor control functions:
 - 1. 1—Fault relay, Form B, NC contact with a rating code of B300 per UL 508.
 - 2. 1—Programmable Auxiliary Relay, Form A, NO contact with a rating code of B300 per UL 508.
 - 3. Programmable auxiliary relay allows for user defined fault identification, fault alarming and fault prioritization, including all protection faults including but not limited to: ground fault, jam, phase imbalance, high and low power,
 - 4. 1—External remote reset allowing for a 120VAC wired remote reset
 - 5. 2—Trip & Reset status indicating LEDs
 - 6. 1 – Door mounted remote display manual reset button
 - 7. 1 – Door mounted remote display Manual trip button
- e. The OLR shall be capable of accommodating external current transformers with ranges from 150:5, 300:5, and 600:5 amperes through a settable CT multiplier on the device for FLAs above 90 amps.
- f. The OLR shall draw its control power from separate source 120 VAC supply not requiring line power to operate it. The OLR shall be suitable for between 47 Hz and 63 Hz.
- g. The OLR shall have selectable trip classes from 5-30; stepped by ones.
- h. The OLR shall be equipped with a dedicated door mounted operator-interface (OI)/ display interface panel. The OI shall have a seven-segment 3-digit LED display for control, programming, monitoring, diagnostic and alarming functions.
- i. The overload relay shall be completely configurable without the use of any proprietary software tool

* Note to Spec. Writer – Select one

- j. The overload relay shall be completely configurable through the use of available communications/industrial network
- k. The OLR relay shall have a minimum of a 10-fault history stored in a non-volatile memory accessible locally on the device without the use of communications
- l. The OLR relay shall have a minimum of a 10-fault history stored in a non-volatile memory accessible remotely through the use of communications/industrial network
- m. The OLR shall announce the following conditions and allow for configuration within the ranges listed:
 - 1. Motor Protection consisting of:
 - a. Thermal overload (FLAs 1-90 without external CTs, up to 540 amps with external CTs)
 - b. Jam, Stall and Current Level Alarming (Settable from 50-400% of FLA, or OFF)
 - c. Current unbalance (Settable from 1-30%, or OFF)
 - d. Current phase loss (60% fixed, or OFF)
 - e. Ground fault (Settable as low as 3 amps to 0.15 amps dependent on the number of wire passes through the current transformers, or OFF)
 - f. Phase rotation/reversal (Settable as OFF, ACB, ABC)
 - 2. Load protection consisting of:
 - a. Under-current (settable from 1-30%)
 - b. Low power (kW) (configurable based on range of device)
 - c. High power (kW) (configurable based on range of device)
 - 3. Line Protection consisting of:
 - a. Over-voltage (settable to 10% above OLR rated voltage)
 - b. Under-voltage (settable to 15% below OLR rated voltage)
 - c. Voltage phase unbalance (settable from 1-30%)
 - d. All Line Protection and Ground Fault shall be settable to alarm only mode or trip mode
 - 4. Protection Trip Delays
 - a. All Motor Protection shall have programmable trip delays by specific trip type from 1-20 seconds
 - b. All Load Protection shall have programmable trip delays by specific trip type from 1-60 seconds
 - c. All Line Protection shall have programmable trip delays by specific trip type from 1-20 seconds
- n. The OLR shall have the following local advanced monitoring capabilities not requiring communications:
 - 1. Current—Average and per phase RMS
 - 2. Voltage—Average and per phase RMS
 - 3. Power—Motor kW
 - 4. Power Factor
 - 5. Frequency
 - 6. Thermal capacity
 - 7. Motor run hours

8. Ground fault current
9. Current unbalance %
10. Voltage unbalance %
- o. The OLR shall have the following additional monitoring capabilities when using one of its industrial networks/communication modules
 1. Time to restart after a line type fault
 2. Time to restart after a motor type fault
 3. Time to restart after a load type fault
 4. Motor Start Count
 5. Overload Relay Status
 6. Error Status
 7. Trip Reason
- p. The OLR shall have the ability to perform auto resets based on programmable timers
 1. The OLR shall have a programmable auto reset for all Motor Type Faults, settable from 2-500 minutes
 2. The OLR shall have a programmable auto reset for Thermal Overload only, settable from 2-500 minutes
 3. The OLR shall have a programmable auto reset for Load Type Faults, settable from 2-500 minutes
 4. The OLR shall have the ability to auto reset for Line Type Faults.
 5. The OLR shall have the ability to limit the number of auto reset attempts to a number set by the user for Motor Type Faults, and a separate number set for Load Type Faults, after which a manual reset is required.
 6. The OLR shall have a programmable restart delay from 1-500 seconds after a power loss has occurred to ensure a deliberate start of multiple loads in a stepped fashion.
 7. The OLR shall have the ability to perform in slow starting high inertia loads, or where a reduced voltage softstarter is being used.
 8. The OLR shall have a settable transition time where protection can be disabled during a start time from 1-180 seconds to accommodate slow starting loads to prevent nuisance tripping.
 9. The OLR shall have a definable run current that can be used concurrently with the programmable transition time to ensure a successful start and then enabling all protection.
 10. The OLR shall have a dedicated remote-mounted display/operator-interface option (C4411) for use with enclosed control or motor control centers *[Type 1 remote display] [Type 12 remote display] [Type 3R remote display].
 11. The remote display shall be powered from the base unit with no need for control power or a power supply.
 12. The base unit shall be able to communicate to the remote display and use one of the industrial protocols concurrently.
 13. The remote display shall allow for configuration, monitoring, diagnostics, and control

* Note to Spec. Writer – Select one

14. The OLR shall have an optional remote-mounted HMI capable of configuration, monitoring, diagnostics, and control of numerous Motor Insight overload relays.
15. The HMI shall be Eaton type XP Series or approved equal.
16. The OLR shall be equipped with the following optional communication module *
 - [Modbus 485 RTU] [Modbus 485 RTU with I/O] [DeviceNet with I/O] [PROFIBUS with I/O] [Ethernet IP with I/O and webserver] [Modbus TCP with I/O and webserver].
 - g. All option communication modules capable of 120 VAC or 24 VDC isolated inputs and form A B300 5 amp rated output relays.
 - h. All option communication modules with I/O must have 4 discrete inputs, and 2 discrete outputs.
 - i. Must work with Power Xpert Gateway and Power Xpert Software

-- *OR --

5. Solid-State Motor Management Relay- C445

- a. Where indicated on the drawings, provide a microprocessor-based Overload Relay (OLR) in each starter and/or where indicated on the drawings for protection, control and monitoring of the motors. The OLR shall be Eaton type C445 (Power Xpert) relay. The OLR shall meet UL 60947-4-1, IEC/EN 60947-4-1, IEC/EN 60947-5-1, EN 60947-8, ATEX 95, and CSA 22.2 #60947-4-1 standards
- b. The OLR shall offer a flexible modular form factor where sensing and protection are broken out in order to provide the most compact configuration possible
- c. The relay shall not require external current transformers for applications up to 136 amperes for motors rated less than 600 Vac. Where larger motors are involved, external current transformers shall be used.
- d. The OLR shall provide both protection and control functionality. OLR shall provide pre-defined operation modes which define input and output behavior if used. The following functionality shall support protection and control.
 1. 1— One primary Fault relay, NO contact with a rating code of B300 per UL 60947-4-1 to be used for both protection and optional control of motor contactor or MCCB
 2. 1— A second output relay, NO contact with rating code of B300 per UL 60947-4-1 to be used in providing both protection and optional control of a second contactor or MCCB when used in wye/delta, two speed, auto-transformer and HMCP/MCCB applications. Output to be available for general purpose use if not required by application.
 3. 1— A third output relay, NO/NC Form C output contact with rating code of B300 per UL 60947-4-1 that can be used in providing both protection and optional control of a third contactor when used in wye/delta, two speed dahlander, and auto-transformer applications. Output to be available for general purpose use if not required by application
 4. 1— An input able to accept 120Vac or 24Vdc run or start signal from local or remote fieldwire control source when required

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* Note to Spec. Writer – Select one

- 5.1— An input able to accept 120Vac or 24Vdc permissive signal from local or remote fieldwire control source when required. Input to be available for general purpose use if 3-wire control is not used
- 6.1— An input able to accept 120Vac or 24Vdc reset signal from local or remote fieldwire control source when required
- 7.1— An input able to accept 120Vac or 24Vdc remote signal from local or remote fieldwire control source when required
- 8. 1— Trip status indicator
- 9.1— Ability to run 2-wire or 3-wire control schemes
- 10.1— Ability to accept local control signals from a user interface or fieldwiring
- 11.1— Ability to accept remote control signals from a fieldbus network or fieldwiring
- e. The OLR shall be capable of accommodating external current transformers with ranges from 300:5, 600:5, and 800:5 amperes. Provide three (3) current transformers sized per manufacturer's recommendations based on motor full-load amperes and service factor.
- f. The OLR shall accept 120/240 Vac *OR 24 Vdc control power. The OLR shall be suitable for application from 20-80 Hz.
- g. The OLR shall have selectable trip classes 5-40.
- h. *The OLR shall be equipped with an operator-interface (OI)/ display interface panel that is safely, remote mountable on the panel door. The OI shall have the following features for control, monitoring, programming and diagnostics
 - 1.1— Status LEDs that indicate a FAULT or WARN condition
 - 1.2— Monitoring window to display current, voltage, power, thermal and other motor system parameters with no network or setup required
 - 1.3— Ability for customer to fully program and customize the device using only the user interface
 - 1.4—Setup Wizard for fast commissioning
 - 1.5—Running, Stopped and Auto Status LEDs with user selectable LED color schemes
 - 1.6—Complete fault description on screen if fault event occurs
 - 1.7—Access to 10 fault queue and trip snapshot
 - 1.8—Dedicated Reset button, that may be disabled if desired
 - 1.9—Optional Local Control functionality that is automatically customized based on operation mode without the need for multiple part numbers or user applied stickers, marking or programming
 - 1.10—Powered off the base device, with no separate power source required
 - 1.11—Optional local password protection
 - 1.12—Micro-USB port for connection to PCs
- i. The OLR shall protect and monitor the following conditions. Where applicable, all protection types will offer both trip and alarm settings with uniquely settable delays.
 - 1. Motor Protection consisting of:
 - a. Thermal overload

* Note to Spec. Writer - Optional

- b. Instantaneous overcurrent
 - c. Jam
 - d. Stall
 - e. Undercurrent
 - f. Current unbalance
 - g. Current phase loss
 - h. Ground fault
 - i. Allowed starts per hour
 - j. Optional PTC protection (Positive Temperature Coefficient)
2. Load protection consisting of :
- a. Low power
 - b. High power
 - c. Power Factor Deviation
3. Line Protection consisting of:
- a. Phase Rotation
 - b. Over-voltage
 - c. Under-voltage
 - d. Voltage unbalance
 - d. Phase loss
 - e. Frequency deviation (fast and slow)
 - f. Voltage loss restart algorithm providing automatic staggered restart of motors during a voltage loss conditions offering (3) user settable time intervals and individual re-start delays
- j. The OLR shall have the following monitoring capabilities:
- 1. Current—Average and phase RMS
 - 2. Current unbalance %
 - 3. Ground fault current
 - 4. Average motor current as % of FLA
 - 5. Maximum motor starting current
 - 6. Voltage—Average line-to-line and L1-L2, L2-L3, L3-L1
 - 7. Voltage unbalance %
 - 8. Power—Motor kW, VA, VARs, real energy, apparent energy, reactive energy, peak demand
 - 9. Power factor
 - 10. Motor speed in RPM
 - 11. Motor torque
 - 12. Thermal memory %
 - 13. Frequency
 - 14. Motor state
 - 15. Operating seconds (total and resettable)
 - 16. Time to trip and reset
 - 17. PTC status

18. Motor run time (total and resettable)
 19. Last measured starting time
 20. Number of starts (total and resettable)
 21. Number of contactor operations last hour
 22. Latest run time
- k. The OLR shall record the following data on fault conditions
1. Active fault
 2. Active warning
 3. Active inhibit
 4. Fault Queue – A list of last 10 faults shown in the order they occurred
 5. Trip snapshot – 12 recorded parameters at time of trip for last trip (current and voltage each phase, ground current, frequency, thermal memory, VA, watts, power factor), optionally time stamped
- l. * The OLR shall provide the following communications without increasing the footprint of the device or requiring a separate power source. The OLR shall provide the user the option to configure communication loss behavior to trip or hold last state.
1. On-board Modbus Serial
 2. * [PROFIBUS communication port with support for DVP0 and DVP1 messages] or [Ethernet communication ports with support for Ethernet/IP and ModbusTCP messaging and web pages. Ethernet will be in the form of a 2 port switch with port forwarding allowing configuration in star, redundant ring topologies, and redundant master topologies.]
 3. USB for connection to a PC for commissioning and monitoring
 4. Free software tool for commissioning and monitoring, which allows the user to save configuration files
 5. Embedded web pages (with Ethernet option)
- m. * The OLR shall provide the following optional functionality
1. Real time stamping
 2. Memory backup module that saves all configuration data to non-volatile memory and copies that data to a new device in the event of device replacement
 3. Four versions of optional password protection – Administrator, USB lockout, Running Lock and User Interface
6. NEMA Size 00 through 2 starters shall be suitable for the addition of at least six (6) external auxiliary contacts of any arrangement normally open or normally closed. Size 3 through 8 starters shall be suitable for the addition of up to eight (8) external auxiliary contacts of any arrangement normally open or normally closed
7. Motor starters shall be Eaton FREEDOM Series or approved equal
- D. Each starter shall be equipped with a fused control power transformer, two (2) indicating lights, Hand-Off-Auto (HOA) selector switch, and two (2) normally open contacts, unless otherwise scheduled on the drawings. A unit-mounted device panel shall have space to accommodate six (6) 30 mm oil-tight pilot-control devices or indicating ammeters, voltmeters, or elapsed time meters. In order to improve maintenance capabilities, the device panel shall withdraw with the unit. Door-mounted pilot devices are not acceptable.

- E. Solid-state reduced-voltage starters, Eaton type S811 shall be provided where shown on the contract drawings. The solid-state reduced-voltage starter shall be UL and CSA listed in the motor control center, and consist of an SCR-based power section, logic board and paralleling bypass contactor. The paralleling bypass contactor shall be energized when the motor reaches full speed. *Each solid-state reduced voltage starter shall have an addressable communication card capable of transmitting control and diagnostic data over an open network to either a personal computer or Logic Controller via network translator to DeviceNet with I/O, Modbus 485, Modbus 485 with I/O, Modbus TCP with I/O or Ethernet IP with I/O.

Note to spec. Writer:

for more detailed specification information for solid-state reduced-voltage starters refer to section 16481, motor starters – low voltage.

- F. Adjustable frequency drives shall be provided in MCC(s) where scheduled. Adjustable frequency drives shall be Eaton type MVX, MMX and/or SVX 9000 and/or DG1 for variable or constant torque loads. Drives for variable torque loads shall be rated a minimum of 110% over-current for one (1) minute. Drives larger than *[1] [10] horsepower shall have identical keypads, control terminals and programmable parameters. Drives shall be capable of providing 200% starting torque. Drives over 150 horsepower shall be located next to the main section to reduce bus loading and heating. All controllers shall be combination type and shall include options as specified. Drives shall have communication cards capable of communication using * [DeviceNet] [Profibus] [LonWorks] [Modbus RTU] [Interbus S] [SDS].[Modbus TCP] [EtherNet/IP]. Drives shall be capable of using a V/Hz, open loop vector, or closed loop vector control architecture.

Note to spec. Writer:

for more detailed specification information for adjustable frequency drives refer to section 16483- adjustable frequency drives.

2.07 OVERCURRENT DEVICES**A. Circuit Breakers**

1. Individual feeder breakers shall have a minimum interrupting capacity of *[65] [100] kAIC at rated voltage or as scheduled on the drawings

B. Fusible Switches

1. Individual feeder switches shall be quick-make, quick-break gang-operated type, utilizing Class [R] [J] fuse clips. The fused switch shall be rated 100 kAIC at rated voltage

2.08 AUTOMATIC INSULATION TESTER

- A. Automatic insulation testers shall be provided for individual MCC motor starter units where indicated on contract documents. The insulation tester shall be rated for 600 VAC, 60 Hz,

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motor circuits. When equipment motor is de-energized, the automatic insulation tester shall automatically apply a 500VDC potential at a current-limited, operator-safe, maximum amperage of 200 micro-amperes to “megger” the insulation of the motor windings and the insulation of the circuit between the automatic insulation tester and the motor. The automatic insulation tester shall have a 10-second time delay before alarm circuit will activate. The insulation tester shall have an input of 120 VAC, 60 Hz and be interlocked with the starter such that the insulation tester will continuously monitor the integrity of the insulation during the period that the equipment motor is de-energized, and upon detection of a leakage current to ground the insulation tester shall provide a visual alarm indication. When the equipment motor is energized, the insulation tester shall be interlocked with the starter to automatically stop testing and be automatically disconnected from the circuit. Insulation tester shall be equipped with 1 (one) Form C latching alarm contact for remote alarm status. Insulation tester shall be provided with a manual reset button and a “test-on” and “alarm” LED display. Automatic insulation tester shall be Eaton Catalog No. MGRDGP500-E. A 2 % analog door-mount meter with a color coded dial and a 0 – 200 meg-ohm scale shall be provided for insulation test indication. The meg-ohm meter shall be Eaton Catalog No. MGRDGP500-E1. An additional 6” of space shall be allowed for this option in size 1 and 2 starters.

2.09 VOLTAGE PRESENCE INDICATOR

A. Voltage Presence Indicators shall be provided on the unit door of MCC starter and feeder units as per contract documents. The voltage presence indicator shall be a hardwired voltmeter or voltage detector connected to the load side of the main incoming disconnect, and shall provide a “through-door” visual indication at the MCC unit door of any voltage presence in any individual phase to enable operators to “pre-verify” voltage presence while the MCC unit door is safely closed. The voltage presence indicator shall be equipped with an adapter to enable installation in a 30mm device-panel on the MCC unit or any other standard 30mm pilot device knockout. The voltage presence indicator shall be of potted construction with 6-foot leads and equipped with dual redundant circuitry to ensure reliability. The voltage presence indicator shall also be phase insensitive, UL type 4X listed and have immunity to high surges. The voltage presence indicator shall be Eaton “VoltageVision™” Catalog No. R-3W.

2.10 FIELD BUS COMMUNICATIONS

A. *DEVICENET DEVICES

1. Motor Control Center assemblies shall be provided with a factory assembled DeviceNet field bus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.
2. The DeviceNet system installed in the MCC shall include a complete and tested cabling system compliant and approved by the ODVA DeviceNet standard. The cabling system

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shall consist of trunk and drop line cabling including all splice and tap connectors and terminating resistors. The trunk and drop cabling shall be 600 Volt insulation and include electrical shielding as per the standard ODVA DeviceNet specification. Non-standard, non-shielded flat cable will not be accepted.

3. The trunk line shall be installed in the top horizontal wireway of the MCC. The trunk line shall be thick cable as specified by the ODVA standard. Sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway shall “T” off the top wireway to drop cable mounted in each of the vertical wireways. Each DeviceNet device shall have a dedicated drop line connection via a T connector. The drop cable shall be thin cable as specified by the ODVA standard. Each section of motor control shall be connected with sealed, threaded, and keyed device tap connectors located and mounted in the top horizontal wireway. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer’s recommendations.
4. DeviceNet communications modules shall be provided at each device interfacing to the DeviceNet field bus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the DeviceNet drop cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated DeviceNet device.
5. Port expanders shall be provided where required to permit multiple device communications. The port expander shall be installed in the associated unit device compartment.
6. Motor control centers shall provide required 24 VDC power to adequately supply power to all the devices in the *[MCC] [Total System], and shall be sized as shown in drawings. The power supply shall be installed in an MCC unit with a disconnect switch, supplementary protection and a cable tap box to prevent damage to/from other power supplies on the network.
7. *Operator interface unit(s) shall be an Eaton XP Series or approved equal.. Operator interface units shall be able to display the following: starter status, three-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, and system process graphics screens. Operator interface shall have the capability of communicating on the DeviceNet network.

B. *PROFIBUS DEVICES

1. Motor Control Center assemblies shall be provided with a factory assembled PROFIBUS field bus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.
2. The PROFIBBUS system installed in the MCC shall include a complete and tested cabling system compliant and approved by the PTO standard. The cabling system shall be a daisy chain using PROFIBUS connectors between each PROFIBUS device. The

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PROFIBUS cabling shall be 600 Volt insulation and include electrical shielding as per the standard PTO specification. Non-standard, non-shielded cable will not be accepted.

3. Each shipping split of motor control shall be connected with sealed, threaded, and keyed connectors located and mounted in the top horizontal wireway. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.
4. PROFIBUS communications modules shall be provided at each device interfacing to the PROFIBUS field bus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the PROFIBUS communication cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated PROFIBUS device.
5. Port expanders shall be provided where required to permit multiple device communications. The port expander shall be installed in the associated unit device compartment.
6. Motor control centers shall provide required 24 VDC power to adequately supply power to all the devices in the *[MCC] [Total System], and shall be sized as shown in drawings. The power supply shall be installed in an MCC unit with a disconnect switch, supplementary protection and a cable tap box to prevent damage to/from other power supplies on the network.
7. *Operator interface unit(s) shall be an Eaton XP Series or approved equal. Operator interface units shall be able to display the following: starter status, three-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, and system process graphics screens. Operator interface shall have the capability of communicating on the PROFIBUS network.

C. *MODBUS TCP DEVICES

1. Motor Control Center assemblies shall be provided with a factory assembled Modbus TCP field bus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.
2. Motor control centers shall provide a required Ethernet 10/100 auto negotiate industrial switch per lineup. The Ethernet switch shall have sufficient ports available to connect to each Modbus TCP device and have at least 2 open ports for a customer connection and a PC connection for maintenance.
3. The Ethernet switch shall be mounted in the top removable unit of each vertical section or shipping split and not in the vertical wireway. If required by the application, the switch shall be capable of connecting to multiple sections.
4. The Modbus TCP system installed in the MCC shall include a complete and tested cabling system. The cabling system shall be Cat 5 and consist of home run connections from the device to a switch located in the MCC. Non-standard, non-shielded cable will not be accepted.
5. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.
6. Modbus TCP communications modules shall be provided at each device interfacing to the Modbus TCP field bus. The communications modules shall be installed in the unit

device compartment or bucket, and shall be direct-connected to the Modbus TCP Ethernet cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated Modbus TCP device.

- 7.*Operator interface unit(s) shall be an Eaton XP Series or approved equal. Operator interface units shall be able to display the following: starter status, three-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, and system process graphics screens. Operator interface shall have the capability of communicating on the Modbus TCP network.

D. *MODBUS SERIAL DEVICES

1. Motor Control Center assemblies shall be provided with a factory assembled Modbus RTU field bus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.
2. The Modbus RTU system installed in the MCC shall include a complete and tested cabling system compliant and approved by Modbus standard. The cabling system shall be a daisy chain using shielded twisted pair cable between each Modbus RTU device. The Modbus RTU cabling shall be 600 Volt insulation and include electrical shielding, non-standard, non-shielded cable will not be accepted.
3. Each shipping split of motor control shall allow for the Modbus RTU cable to be disconnected for shipment and then reconnected during installation. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.
4. Modbus RTU communications modules shall be provided at each device interfacing to the Modbus RTU field bus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the Modbus RTU communication cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated Modbus RTU device.
5. *Operator interface unit(s) shall be an Eaton XP Series or approved equal. Operator interface units shall be able to display the following: starter status, three-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, and system process graphics screens. Operator interface shall have the capability of communicating on the Modbus RTU network.

E. EHTERNET/IP DEVICES

1. Motor Control Center assemblies shall be provided with a factory assembled EtherNet/IP field bus communications network providing direct connectivity between MCC devices and the system controller and/or HMI.

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2. Ethernet 10/100 auto negotiate layer 2 managed industrial switches shall be provided as required in the MCC lineup. The Ethernet switch shall have sufficient ports available to connect to each EtherNet/IP device and have at least 2 open ports for a customer connection and a PC connection for maintenance. The Ethernet switch shall be mounted in the top removable unit of each vertical section or shipping split and not in the vertical wireway. If required by the application, the switch shall be capable of connecting to multiple sections.
 3. The EtherNet/IP system installed in the MCC shall include a complete and tested cabling system. The cabling system shall be 600V Cat 5 and consist of home run connections from the device to a switch located in the MCC and in accordance with the ODVA specification. Non-standard, non-shielded cable will not be accepted.
 4. It shall be permissible to daisy chain Ethernet/IP devices using a 2-port switch configuration in each device unit or bucket and not use the home run topology.
 5. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer's recommendations.
 6. EtherNet/IP communications modules shall be provided at each device interfacing to the EtherNet/IP field bus. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the EtherNet/IP Ethernet cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated EtherNet/IP device.
- ** *Operator interface unit(s) shall be an Eaton XP Series or approved equal. PanelMate * [Power] [ePro] Series. Operator interface units shall be able to display the following: starter status, three-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, and system process graphics screens. Operator interface shall have the capability of communicating on the EtherNet/IP network.

2.11 MISCELLANEOUS DEVICES

2.12 INCOMING FEEDER TERMINATIONS AND DEVICE

- A. Incoming *[cable] [busway] shall terminate within the control center on a *[main lug] [main breaker] termination point. Main lug terminations shall have adequate dedicated space for the type and size of cable used and the lugs shall be *[standard mechanical screw] [compression-type] with anti-turn feature. Main breakers shall be provided as indicated on the drawings and shall be *[molded case] [power circuit breakers, stored energy device].

2.13 OWNER METERING

- A. Where indicated on the drawings, provide a separate, owner metering compartment with front hinged door.

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- B. Provide as a minimum of three (3) current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- C. *Provide *[potential transformers including primary and secondary fuses with disconnecting means] [fused potential taps as the potential source] for metering as shown on the drawings.

***Note to spec. Writer:**

select devices as required for paragraph 2.13.D
Refer to section 16901 for detailed specification for metering.

- D. Microprocessor-Based Metering System.
- E. * Web-Enabled Communications
 1. Where indicated on the drawings, provide a separate compartment with a front facing hinged door as a central point of connection for all internally located communicating devices to an external Ethernet network and allow close monitoring of the power infrastructure with real-time, web-enabled data.
 2. The compartment shall have a lockable, hinged door with a functional through-the-door RJ45 network access port. Power for the components in the compartment shall be supplied by a pre-wired, bus-connected control transformer in the compartment that is fused and has a disconnecting means.
 3. The included communications components shall be a [Power Xpert Ethernet Switch(es)] [Power Xpert Gateway(s)], which [is] [are] specified in Section 16911-1(should specify paragraphs in the section).

2.14 ENCLOSURES

- A. The type of enclosure shall be in accordance with NEMA standards for *[type 1A with gasketed doors] [type 12 dust-tight and drip-proof] [type 3R non-walk-in] [type 3R walk-in aisle] [type 3R walk-in tunnel]. All enclosing sheet steel, wireways and unit doors shall be gasketed.

2.15 NAMEPLATES

- A. Each unit will have a 1.0 x 2.5-inch engraved nameplate. The lettering shall be 3/16-inch high, black on a white background.

2.16 FINISH

- A. The control center shall be given a phosphatizing pretreatment. The paint coating shall be a polyester urethane, thermosetting powder paint. Manufacturer's standard color shall be used. All structural steel and panels will be painted.
- B. The control center finish shall pass 600 hours of corrosion-resistance testing per ASTM B 117.

2.17 *CLEAN MOTOR CONTROL CENTER

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- A. The Clean Motor Control Center shall consist of a Eaton F2100 design Motor Control Center and integral harmonic correction unit for the attenuation of harmonics induced by nonlinear loads such as ac Adjustable Frequency Drives.
- B. The harmonic correction unit for the Clean Motor Control Center shall be in a totally enclosed dead-front and incorporated into the MCC assembly complete with pass-through bus allowing for future expansion of the MCC. Structures shall be 90 inches high and 21 inches deep for front-mounted units. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus by metal barriers and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.
- C. An operating mechanism shall be mounted on the primary of each harmonic correction unit. It shall be mechanically interlocked with the door to prevent access unless the disconnect is in the "OFF" position. A defeater shall be provided to bypass this interlock. With the door open, an interlock shall be provided to prevent inadvertent closing of the disconnect. Padlocking facilities shall be provided to positively lock the disconnect in the "OFF" position with from one (1) to three (3) padlocks with the door open or closed.
- D. Harmonic Correction Units shall be disconnected from the power source by a molded case switch. All units shall include 200,000 AIC rated fuses with Class T actuation. All units shall be provided with a grounding lug. Grounding by the contractor shall be performed according to local and national standards.
- E. The harmonic correction units shall be sized to meet 5% total harmonic current distortion {THD (I)}, 5% total demand distortion (TDD), and <5% total harmonic voltage distortion {THD (V)} levels as defined by IEEE 519-1992 at **incoming line terminals of the motor control center] [system Point of Common Coupling as defined in IEEE519]. The harmonic correction unit shall be integral to Eaton F2100 Motor Control Centers.
- F. The harmonic correction unit shall be designed in accordance with the applicable sections of the following standards. Where a conflict arises between these standards and this specification, this specification shall govern.
1. ANSI IEEE standard C62.41-1991 [Surge Withstand Capacity]
 2. CSA 22.2, No. 14 & 66 [CSA requirements for power electronics]
 3. FCC Part 15, Sub Part J, Class A [RFI/EMI emission standards]
 4. ANSI IEEE standard 519-1992 [Harmonic limits]
 5. UL 508C [UL requirements for power conversion equipment]
- G. The motor control center manufacturer shall install the harmonic correction unit in the motor control center. The harmonic correction unit shall be approved by UL or CSA for installation in the motor control center.
- H. Modes of Operation
1. The harmonic correction unit shall be designed to electronically inject harmonic current to cancel load produced harmonic current such that the upstream power harmonic current

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and voltage are reduced to below 5% TDD and 5% THD (V) as defined by ANSI IEEE standard 519-1992 for load demand and voltage distortion limits. TDD as used herein refers to the total load demand of the applied circuit. The applied circuit may be a single nonlinear load, an entire distribution bus load, or the facility load at the Point-of-Common Coupling (PCC)

2. Reactive current compensation (displacement power factor correction) shall be activated via a digital keypad/display mounted on the door of the enclosure. When reactive current compensation is activated, the harmonic correction unit shall first perform harmonic current correction and then use the remaining capacity to inject reactive current compensation to the specified level herein defined

I. Design

1. Each unit of the harmonic correction units shall meet FCC Part 15, Sub Part J, Class A requirements for both radiated and conducted EMI
2. All harmonic correction units shall be defined as a power electronic device consisting of power semiconductors that switch into the AC lines to modulate its output to cancel detrimental harmonic and/or reactive currents. A DC bus shall store power for power semiconductor switching. A microprocessor shall control the operation of the power converter
3. Each unit shall be designed with a current limiting function to protect the semiconductors. When this level is attained, a message shall be displayed indicating the output capacity is at-maximum capacity and actuate the at-maximum capacity relay. Operation shall continue indefinitely at this level without trip off or destruction of the power correction unit
 4. Two distinct levels of faults shall be employed. Non-critical level faults will provide automatic restart and a return to normal operation upon automatic fault clearance. Critical level faults stop the function of the unit and await operator action
 - a. Faults such as ac line over-voltage, AC line under-voltage, AC line power loss, and AC line phase imbalance shall be automatically restarted. Upon removal of these fault conditions, the power correction system shall restart without user action. Automatic restart will not occur if 5 faults have occurred in less than 5 minutes. During the fault condition, except line loss, the display shall state the type of fault and indicate that automatic restart will occur. The run relay and run LED shall be disabled. The fault relay shall not be enabled unless time out occurs. Upon AC line loss, the power-on relay shall be disabled and no display shall be provided.
 - b. All other types of faults shall be considered critical and stop the power correction system. The display shall indicate the fault condition and "STOP." The run LED and relay shall be disabled and the fault relay enabled. User shall be required to initiate a power reset (turn power OFF and ON) to restart the power correction system.
5. The logic of the harmonic correction unit shall monitor the load current by utilizing two (2) current transformers (CT's) mounted on phases A and B to direct the function of the power electronic converter. A third current transformer is required if single-phase or three-phase line-to-neutral connected loads are present downstream from the location of the CT's. The ratio of the CT's must be entered into the logic via the digital keypad/display to calibrate the operation of the power correction system. The output of the current transformers shall be 5 amperes

6. Up to three (3) harmonic correction units may be installed in parallel to inject current according to the information received from one set of CT's. The units will function independently. If one unit is stopped or faulted, the remaining units will adjust accordingly to maintain optimum harmonic cancellation levels up to the capacity of the remaining units
- J. Performance Requirements
1. Input Power:
 - a. Voltage: 480 Volt, 3-phase, 3-wire, plus ground
 - b. Voltage Tolerance: +/- 10% of nominal
 - c. Frequency: 60 Hz, +/- 5%
 - d. Current Limit: 100% of rating
 - e. Surge Withstand Capability: ANSI/IEEE std. C62.41-1991 without damage
 - f. Input Fuses: Rated at 200 kAIC, Class J.
- K. Output Performance
1. Performance of the harmonic correction unit shall be independent of the impedance of the power source. All performance levels shall be attained whether on the ac lines or backup generator or output of the uninterruptible power supply (UPS)
 2. Harmonic Correction:
 - a. Limit 2nd through 50th order harmonic current to <5% TDD as defined in ANSI/IEEE STD 519-1992 at each installed location. Harmonic levels for individual harmonic orders shall comply with respective levels established in ANSI/IEEE STD 519-1992.
 - b. Limit the THD (V) added to the electrical system immediately upstream of the power correction system location(s) to less than or equal to 5% as defined in ANSI/IEEE STD 519-1992. The power correction system shall not correct for utility supplied voltage distortion levels.
 3. Reactive Current Compensation: to .90 lagging displacement power factor. Leading power factor is not permitted
- L. Environmental Conditions
1. The harmonic correction unit shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics or life
 - a. Operating Ambient Temperature: 0 degrees C (32 degrees F) to 40 degrees C (104 degrees F).
 - b. Storage Temperature: -40 degrees C (-40 degrees F) to 65 degrees C (149 degrees F).
 - c. Relative Humidity: 0 to 95%, non-condensing.
 - d. Altitude: Operating to 2000 meters (6500 ft). Derated for higher elevations.
 - e. Audible Noise: Generated by power correction system not to exceed 65 dbA measured 1 meter from surface of unit.
 - f. Vibration: Seismic Zone 4.
- M. Current Transformers
1. Split core type current transformers shall be installed as defined herein and shown in the electrical drawings. Current transformers shall be rated for the total rated RMS current of the total load at each installed location

2. Two current transformers per power correction system location shall be provided and shall be mounted on phases A and B. A third current transformer shall be provided if single or three-phase line-to-neutral connected loads are present downstream from the location of the CT's
3. Each current transformer shall have a current output of 5 amperes. Current capacity of each current transformer shall be 5000, 3000, 1000 or 500, as required for the electrical system where installed. No other ratings are acceptable
4. Each current transformer shall be rated for 400 Hz

N. Operator Controls and Interface

1. All units shall include a digital interface model (DIM) that includes an alphanumeric display consisting of 2-lines with 20 characters per line. All information shall be in English. Operators include run, stop, setup, enter, and up/down scroll
2. The display shall provide operating data while functioning. Standard operating parameters available for display are ac line voltage, total RMS load current, harmonic current of load, reactive current of load, output harmonic and reactive current of power correction system
3. When the output of the power correction unit is at full rated capacity, the display shall indicate at-maximum capacity and actuate an at-maximum capacity relay
4. All fault conditions shall be displayed as they occur. Diagnostic information shall be provided in English and clearly indicate the nature of the fault
 5. The run pushbutton shall include a green LED. LED shall be lighted when unit is running
 6. Contacts shall be provided for operator information for power-on, run, fault and at-maximum capacity. Each contact shall be rated for 1 ampere at 120/240 volts. One Form C contact shall be provided for each relay
 7. An RS-485 serial communication port shall be provided for remote control and diagnostic information.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. Representative motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.
- B. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.
- C. A certified test report of all standard production tests shall be available to the Engineer upon request.
- D. *The owner's representative shall witness factory tests as outlined above
 1. The manufacturer shall notify the owner two (2) weeks prior to the date the tests are to be performed.

3.02 FIELD QUALITY CONTROL

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- A. Provide the services of a qualified factory-trained manufacturer's representative to perform startup of the equipment specified under this section for a period of *_____ working days.
- B. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:
 - 1. Rig the MCC assembly into final location and install on level surface
 - 2. Check all removable cells and starter units for easy removal and insertion
 - 3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus
 - 4. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 TRAINING

- ** The Contractor shall provide a training session for up to five (5) owner's representatives for *_____ normal workdays at the job site or other office location chosen by the owner.
- B. A manufacturer's qualified representative shall conduct the training session.
- C. The training program shall consist of the following:
 - 1. Review of the MCC one-line drawings and schedules
 - 2. Review of the factory record shop drawings and placement of the various cells
 - 3. Review of each type of starter cell, components within, control, and power wiring
 - 4. Review contactor coil replacement and contact replacement procedures
 - 5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program
 - 6. Provide three-ring binders to participants complete with copies of drawings and other course material covered

3.04 EXAMINATION

- A. Contractor shall fully inspect shipments for damage and report damage to manufacturer and file claim upon shipper, if necessary.
- B. Contractor shall supply overload relay heater ratings that are properly sized and coordinated for each motor starter unit.

3.05 INSTALLATION

- A. Contractor shall follow the installation instructions supplied by the manufacturer.
- B. Control wiring shall be as shown on the contract drawings except as modified by the approval and submittal process. Interface all local and remote devices into the control wiring and operational systems for each load.

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- C. *As Shown on the contract drawing, Contractor is to provide all DeviceNet trunk and drop cabling with threaded, sealed and keyed device taps external to the MCC.

3.06 FIELD ADJUSTMENTS

- A. The Contractor shall perform field adjustments of the short circuit and overload devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, protective device coordination study, manufacturer's instruction leaflets, and the contract documents.

3.07 FIELD TESTING

- A. Contractor is responsible for generation of a field report on tests performed, test values experienced, etc., and make the report available to owner upon request.

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