

SECTION 26 24 19 – MOTOR CONTROL CENTERS

1.01 SUMMARY:

- A. **Basic Function:** Motor Control Centers (MCC) shall be used to power, protect and control motors operating the gates, valves and other loads.
- B. ^{A16}**Scope of Work:** Motor ^{A17}control centers ^{A17} (MCC) shall be installed in rooms where motors are located and required to be powered and controlled. ^{A16} The equipment shall be an indoor mechanical grouping of combination motor control and feeder taps arranged in a convenient assembly. MCC's will also include protection, monitoring and the control system associated to the system to be controlled.

1.02 ^{A16}REFERENCES: ^{A16}

A. **American National Standards Institute (ANSI) Standards:**

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| C37.50-00 | Standard Test Procedures for Switchgear-Low Voltage AC Power Circuit Breakers Used in Enclosures |
| C37.51-03 | Switchgear – Metal Enclosed Low-Voltage AC Power Circuit-Breaker Switchgear Assembly |
| C37.52 -00 | Test Procedures for Low-Voltage AC Power Circuit Protectors used in Enclosures |

B. **American Society for Testing and Material (ASTM) International Standards:**

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| B 187/B 187M -- 06 | Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes |
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C. **International Electrotechnical Commission Standards:**

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| IEC 61000-4-30-- 08 | Testing and Measurement Techniques – Power quality measurement methods. |
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D. **Institute of Electrical and Electronics Engineers (IEEE) Standards:**

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|-------------|--|
| C37.13-95 | Standard Rating for Low –Voltage AC Power Circuit Breakers Used in Enclosures |
| C37.17-97 | Standard Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers |
| C37.20.2-05 | Standard for Metal-Clad Switchgear |
| C37.20.1-06 | Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear |

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|----------------|---|
| C37.29-90 | Low-Voltage AC Power Circuit Protectors Used in Enclosures |
| C57.12.29 – 05 | Standard for Pad Mounted Equipment Enclosure Integrity for Coastal Environment |
| 519 -04 | Recommended Practice and Requirements for Harmonic Control in Electrical Power System |
- E. **National Electrical Manufacturers Association (NEMA) Publications:**
- | | |
|-----------|---|
| C12.1-01 | Code for Electricity Metering |
| AB 1-02 | Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures |
| ICS 2-06 | Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC |
| ICS 6- 06 | Industrial Control and Systems: Enclosures |
| ICS 18-04 | Industrial Controls and Systems: Motor Control Centers |
| SG 5-95 | Power Switchgear Assemblies |
| ST 20-97 | Dry-Type Transformers for General Applications |
- F. **National Fire Protection Association (NFPA) Publications:**
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|----------|--------------------------------|
| 70 -- 08 | National Electrical Code (NEC) |
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- G. **Underwriters Laboratories Inc. (UL) Safety Standards:**
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|---------|--|
| 44-05 | Thermoset-Insulated Wires and Cables |
| 489-06 | Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures |
| 845 | Motor Control Centers |
| 1063 | Machine-Tools Wires and Cables |
| 1558-06 | Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear |

1.03 REQUIREMENTS:

A. Input Harmonics:

1. Distribution system shall comply with the latest edition of IEEE 519 for total harmonic voltage and current distortion calculation and measurement and meet the following distortion limits:
 - a. **Voltage Harmonics:** Not more than 3% total harmonic voltage distortion while operating from the utility source, or not more than 5% while operating from standby generator.
 - b. **Current Harmonics:** Maximum allowable total harmonic current distortion limits shall not exceed 5%.

B. Capacity: Equipment bus bar shall be sized to carry the electrical load without exceeding 75% of the nominal MCC rating in normal operation, in addition to having the capacity to carry the load connected and the transferred load from the adjacent redundant MCC bus bar, in case of failure of the source to the adjacent MCC. ^{A5}At a minimum, shall be capable to support the maximum short circuit level resulting from the short circuit level study required in Section 26 05 73 (*Short Circuit and Load Flow Coordination Study*) without any damages. All equipment shall be sized at the same interrupting capacity level. ^{A5}

C. Communication and Control: All control and monitoring shall be performed through the ^{A17}ethernet network, except when there is a regulation against it. Alarms for every motor shall be programmed in the main control system, a local display shall also be provided. Redundant fiber optic connection for communication is mandatory. ^{A17} See Section 01 81 26 (*Communications, Control, Safety and Security Systems*)

D. Environmental: The MCC system shall be capable of continuous operation in an average ambient temperature between 20°C and 40°C at sea level. The equipment shall also be suitable for continuous operation in a maximum humidity between 70% and 95% non-condensing.

E. Standard Products: Materials and equipment shall be standard cataloged products of manufacturers regularly engaged in the commercial production of these products and shall be the latest standard design that conforms to the specifications.

F. Marking: Internal equipment wiring marking shall be as per Section 26 05 53 (*Identification for Electrical Systems*).

G. Corrosion Resistance: All interior and exterior ferrous metal shall be cleaned and painted with corrosion protective coating system as per IEEE C57.12.29 and Section 09 06 00 (*Corrosion Control Coatings*).

1.04 ^{A7}DESIGN CRITERIA/SYSTEM DESCRIPTION AND PERFORMANCE:^{A7}

A. General: Motor control centers shall be 600-Volt class suitable for operation on a three-phase system. This equipment will operate at a service voltage of 480/277V, 60 Hz,

three-phase, four-wire, grounded wye. All the control circuits and its components shall be rated for 125VDC operations. Motor control centers shall be designed and manufactured in accordance to NEMA ICS 2, NFPA 70, UL 845 and UL 1558.

- B. **Nameplates:** Equipment shall have manufacturer's name, address, catalog number, model, style or type identified and technical data as voltages, current, Hz, etc. on a plate securely and conspicuously attached to each item of equipment. Nameplates for electrical apparatus shall be stainless steel and conform to NEMA standards.

C. **Low Voltage Motor Control Center:**

1. **General:** The Contractor shall furnish an indoor motor control center as specified below:

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| a. | Rated current: | sized by designer |
| b. | Phases: | 3 |
| c. | Hertz: | 60 |
| d. | Rated Voltage: | 600 V |
| e. | System Voltage: | 480Y/277V |
| f. | Basic Impulse Insulation Level (BIL): | 30 kV |

2. **Construction of Motor Control Center (MCC):**

- a. Structures shall be totally enclosed, NEMA type 1, and freestanding assemblies. Structures shall contain a horizontal wireway at the top, isolated from the horizontal bus and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top and bottom shall be provided without structural interference. Metal thickness for enclosures shall be not less than specified in NEMA ICS 6.
- b. Compartments for mounting tap feeders shall be incrementally arranged such that not more than twelve units can be mounted within each vertical structure.
- c. Each operating unit shall contain equipment as shown on the contract drawings, mounted in an individual cell. All units shall be draw-out type removed from the front, without rear access or disturbing other units in the control center assembly (starters and tap feeders units). All draw-out type unit assemblies shall have positive guide rail system to ensure alignment of connection to vertical bus. Units shall be mechanically interlocked with the door to prevent removal while in the energized position. All ventilating openings shall be provided with corrosion-resistant insect-proof screens on the inside. Draw-out units shall have a silver-plated stab assembly for connection to the vertical bus.
- d. Wiring and terminations shall be Class II Type B as indicated on NEMA ICS 18. Terminal blocks for control wiring shall be molded or fabricated type with barriers rated not less than 600 volts. The terminals shall be

washer head screw type, or of the stud type with contact and locking nuts. The terminals shall be not less than No. 10 in size and shall have sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal. Each block or group of blocks shall have not less than 10 percent spare terminals. Minimum current-carrying capacity shall be 20 Amps. Short-Circuiting Type terminal blocks shall be furnished for all current transformer secondary leads and shall have provision for shorting together all leads from each current transformer without first opening any circuit.

- e. Each wire and terminal block shall be marked. Terminal blocks marking shall include corresponding wire designation.
- f. Load terminal blocks shall be copper rated not less than 600 volts and of adequate capacity shall be provided. The terminals shall have length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, screws shall have hexagonal heads. Conducting parts between connected terminals shall have adequate contact surface and cross-section to operate without overheating and rated 75°C at least. Each connected terminal shall have the circuit designation or wire number placed on or near the terminal in permanent contrasting color. Aluminum terminal blocks are not acceptable.
- g. No wiring to the stab assembly shall extend into the bus compartment.
- h. 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.
- i. A spring-loaded fastening device shall secure all draw-out units.
- j. Each unit compartment shall be provided with an individual front door and an engraved nameplate with white lettering on black background identifying the load fed by the respective unit compartment.
- k. An operating mechanism shall be mounted on the primary breaker of each starter and tap feeder unit. It shall be mechanically interlocked with the unit door to prevent access unless the breaker 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 breaker. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position.
- l. Padlocking facilities shall be provided to positively lock the operating mechanism in the OFF position, with the door open or closed.
- m. Station ^{A17}service ^{A17} transformer shall be part of the MCC. The station service transformer shall be 480:240/120 Volts, single phase, dry type. Transformer shall conform to the requirements of Section 26 22 00 (*Dry*

Type Transformers) and shall have adequate volt-ampere capacity for the functions indicated. Transformer shall be installed with primary and secondary protection (fuses or breaker). One secondary lead shall be grounded.

- n. Each section shall have a space heater mounted in the bottom of the breaker cell, the bus compartment and the cable compartment. Each space heater shall be rated at 50 watts minimum at 120 volts AC. Power for the space heaters shall be feed from the Power transformer.
3. **Motor Control Center MCC Bus:** The bus system shall be designed to efficiently distribute power throughout the MCC and provide inherent mechanical strength in the event of faults. All the bus shall be copper and it shall be rated at 65 °C temperature rise over a 40 °C ambient in compliance with UL standard 845, ASTM 187 and NEMA SG-5.
- a. The main horizontal bus shall have the continuous current rating calculated by Contractor and shall provide three-phase power distribution from the incoming breakers to each vertical structure in the motor control center. Bus joints shall be silver or tin-plated with at least two silicon bronze bolts on each side of the joint. The current rating of the main horizontal busses shall be suitable to carry all electrical loads connected to both busses. The current rating shall be minimum 1200 ampere. Bus braces shall be molded from high strength glass-reinforced polyester materials which is non-tracking and resistant to moisture and other adverse atmospheric operating conditions. At a minimum, the bus shall be braced for a short circuit current of 65,000rms symmetrical amperes.
 - b. The vertical bus shall have a minimum rating of 300 amperes and a maximum of 1200 amperes, depending on the size of the feeders ascribed to the vertical section, and it shall provide three-phase power distribution from the main horizontal bus to the vertical compartments. Bus braces shall be molded from high strength glass-reinforced polyester material which is non-tracking and resistant to moisture and other adverse atmospheric operating conditions.
 - c. 600 Volts clearances shall be maintained in all horizontal and vertical buses.
 - d. A horizontal grounding bus shall be provided with a minimum rating of 500 amperes continuous current rating.
4. **Motor Controller and Feeder Cell Units:** These units shall consist of the combination of a motor starter and a disconnecting device of proven capability grouped within a rugged metal enclosure and plug-in cell design. These cells will control electrical motor coupled to any type of equipment. Motor characteristics shall be described by Contractor in a contract drawing. All motors shall be as minimum class C, code F, and insulation class F with class B insulation temperature rise.
- a. An industrial molded case circuit breaker as disconnecting device shall have the withstand capacity not lower than the interrupting capacity

value calculated in Section 26 05 73 (*Short Circuit and Load Flow Coordination Study*) at 480 volts for motor circuit protection. The breaker shall provide adjustable magnetic protection and shall be provided with pin insert to stop magnetic adjustment at 1,300% motor nameplate full load current in order to comply with NFPA 70 requirements. Molded case circuit breakers type shall conform to the applicable requirements of NEMA AB 1 and UL 489. The circuit breakers shall be manually operated, shall be quick-make, quick-break, common trip type, and shall be of automatic-trip type. Circuit breakers shall be Molded Case type conforming to IEEE C17.3, C37.17, NEMA AB-1, and UL 489. All poles of each breaker shall be operated simultaneously by means of a common handle. The operating handles shall clearly indicate whether the breakers are in "On," "Off," or "Tripped" position and shall have provisions for padlocking in the "Off" position. Personnel safety line terminal shields shall be provided for each breaker. The circuit breakers shall be products of only one manufacturer, and shall be interchangeable. Circuit breakers shall be provided with a push-to-test button and bell alarm contacts that close on automatic operation only. The contacts shall be suitable for 125 volts dc and shall reset when the breaker is reset.

- b. Magnetic contactors shall be of the NEMA sizes indicated on the contract drawings. The rating, performance and service characteristics shall conform to the requirements of NEMA ICS 2 for contactors with continuous current ratings for the duty indicated. Contactors for motor control shall be rated for full-voltage starting (Class A controllers). Contactors shall be suitable for at least 200,000 complete operations under rated load without more than routine maintenance. Contactors shall have air or vacuum arc extinguishing provisions. If air arc extinguishing is provided, arc chutes and silver-to-silver contacts shall be easily removable without dismantling other parts. The contactor shall operate without chatter or perceptible hum while energized. ^{A16}Coils shall be suitable for continuous operation +24 Volt DC circuits. ^{A16}Alternating-current contactors shall be three-pole and be insulated for 600 volts AC and of the electrically operated, magnetically held type. It shall have provisions for [normally closed \(NC\)](#) and [normally open \(NO\)](#) auxiliary contacts.
- c. The overload protection shall consist of one current sensor located in each phase monitored by a microprocessor that yields a time current curve closely paralleling that of the motor's heating damage boundary, accurate to 2%. The running overload protection shall be selectable for the specific full load amperes within the starter range. The starter shall also include the following features:
 - 1) Phase loss and phase unbalance protection, such that if the unbalance of any two phases is greater than 30% of the selected trip rating, a phase loss/unbalance trip occurs. This phase unbalance protection shall not require time delay for reset.

- 2) An operated interface communications card capable of transmitting over an Ethernet port the following information/control to a communications network compatible with Modem, Ethernet, Mod Bus gateway, RS-232 gateway or RS-232 connection; and the following functions:
 - a) On-Off and reset control functions
 - b) Status
 - c) Current in each phase
 - d) Voltage in each phase
 - e) Percent phase unbalance
 - f) Control voltage
 - g) Overload protection settings
 - h) Cause of trip
 - i) Trip current magnitude
 - d. All the motors control units shall be made with a rigid steel shell, gage as required by NEMA ICS 6. The material shall receive rust inhibiting phosphatizing treatment and have an enamel finish per ANSI standards. The rear section of the shell shall have a silver-plated copper alloy stab assembly mounted in a glass-reinforced plastic insulation block that totally shrouds each stab and ensures positive alignment of the stabs with the vertical bus. The stab assembly shall ensure a positive connection yet permit easy unit insertion and withdrawal. The power wiring shall be firmly connected to the stabs and totally contained within the unit enclosure.
 - e. All the motor control units shall have a NEMA Type B wiring that will enable all the control wires to terminate at terminal blocks located on the side or near the bottom of each unit. Load terminals shall also be provided.
 - f. All the motor control units shall include a red and green indicating lamp on the front compartment door for line starter contact position.
 - g. All control wire shall be stranded tinned copper switchboard wire with 600-volt flame-retardant insulation Type SIS meeting UL 44 or Type MTW meeting UL 1063, and shall pass the VW-1 flame tests included in those standards. Hinge wire shall have Class K stranding. Current transformer secondary leads shall be not smaller than No. 10 AWG. The minimum size of control wire shall be No. 14 AWG. Power wiring for 480-volt circuits and below shall be of the same type as control wiring and the minimum size shall be No. 12 AWG.
5. **MCC Feeder Tap Units:** Tap feeders consist in a draw-out cell with molded case circuit breakers that will feed a determinate load. This cell does not have any control, except for breaker trip alarm contact. They shall be draw-out, single

or dual mounted units containing interchangeable trip Type KD circuit breakers or equal.

6. **Sheet Steel:** Minimum sheet metal thickness shall be as required by NEMA ICS 6, on all exterior surfaces. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating.
7. **Nameplates:** Engraved nameplates, mounted on the face of the assembly, shall be furnished for all feeder and main circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background and secured with screws. Characters shall be 3/16-inch high, minimum.
8. **Incoming and Bus-Tie Units:** Incoming and bus-tie breakers shall be rated to Bus ampacity, and insulation of 600V.
 - a. The incoming breakers shall include all the characteristics of the Motor control units for wiring and communication. For protection, incoming units shall include as a minimum: transformer differential when it applies 87T, over-current (50/51), directional over-current (67), ground fault protection and shunt trip unit. Cable entrance provision shall be able to accept multiple 500kCM copper conductors per phase. Aluminum cable entrance terminals are not acceptable.
 - b. The bus-tie breaker shall not have any protection at all, it will act only as a disconnect device. But it shall have remote control provisions.
9. **Power Monitor Device:** Units shall comply with IEC 61000-4-30 Class A equipment, be microprocessor based, for 3 phase circuits with configurable alarms, for use with current transformers (CTs), potential transformers (PTs) and equipped with a power module as required for operation.
 - a. Each incoming breaker shall be equipped with a solid-state power monitor with features to monitor the following:
 - Voltage: Per phase, average and unbalance
 - Current: per phase, average and unbalance
 - Power: real, apparent, reactive, power factor
 - Frequency
 - Energy, 4 quadrants (bi-directional)
 - Voltage Harmonics (up to the 30th or higher)
 - Current Harmonics (up to the 30th or higher)
 - THD for voltage
 - THD for current
 - Store in memory: kW-hours, kVAR-hours, and kW demand, (resetable)
 - kW-hour accuracy shall be 0.50% or higher
 - Shall include an interface card to permit communication via Ethernet network for remote monitoring and control
 - Shall have communication and protocol compatibility to the system described in Section 40 95 13.19 (*Process Control Hardware for Electrical Distribution Control Systems (EDCSs)*).

- b. True rms sensing circuit shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and display instant kVA, kW, **kVAR**, power factor, voltage and current.
- c. Also be able to keep in memory kW-hours, **kVAR-hours**, and kW demand (reseteable).
- d. An interface card to permit communication via Ethernet network for remote monitoring and control.

1.05 ^{A7}**SUBMITTALS:**^{A7}

A. ^{A7}**Before Manufacturing:**^{A7} The Contractor shall submit to the Employer's Representative the following information, as a minimum, for review:

- 1. Diagrams, drawings and literature describing the equipment and including, but not limited to, the following items:
 - a. Estimated layout dimension, weight, and accessory equipment
 - b. Descriptive literature for the motor control center, breakers, transformers, instruments, protective relays, including materials used, painting process, insulation system, maintenance requirements and other data.
 - c. Copy of switchgear manufacturer's UL certification for motor control centers fabrication.
 - d. Connection diagrams.
 - e. Equipment nameplate information
 - f. AC schematic drawings for the MCC control circuits
 - g. AC single line diagram and equipment electrical ratings

B. **Before Shipment:** The Contractor shall submit to the Employer's Representative the following information, as a minimum, for review:

- 1. **Factory Test Reports:** Submit certified factory test reports of all factory tests performed by the manufacturer, including tests required by the applicable standards. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted following successful completion of the tests.
- 2. ^{A16}**Field Test Procedures:** Submit copies of installation manuals and field test procedures for the motor control centers and related subsystems.^{A16} The manufacturer's pass/fail criteria for field tests shall be included.
- 3. **Field Test Plan:** Submit a proposed field test plan, prior to testing equipment and subsystems. No field test shall be performed until the test plan has been reviewed by the Employer's Representative. The test plan shall consist of the manufacturer recommended field test procedures, including tests to be

performed, qualifications of personnel performing the testing, test equipment required, pass/fail criteria, and tolerance limits. Field testing, in addition to the manufacturer recommendations, shall be in accordance with the applicable requirements in Section 26 90 00 (*Field Testing Electrical Systems*). After completion of field testing, submit Certified Field Test Reports.

C. **Before Taking Over:** The Contractor shall furnish the following documents:

1. As-built AC schematic drawings, as well as complete wiring drawings for each cubicle
2. One copy of each as-built drawing in AutoCad format on CD
3. Installation, operation, and maintenance manuals, with copies of all drawings, reduced size format.
4. ^{A16}**Reserved.** ^{A16}

1.06 ^{A7}**QUALITY ASSURANCE:** ^{A7}

- A. **Manufacturer:** The manufacturer shall be a firm specialized in manufacturing motor control centers with minimum ten years documented experience.
- B. **Applicable Standards:** The motor control center shall be designed and tested by the Manufacturer in accordance with applicable standards.
- C. **Defective Material:** Defective material or material damaged in the course of shipment, transportation or test shall be replaced or repaired in a manner meeting with the approval of the Employer's Representative.
- D. **Certifications:** All motor control centers shall be UL listed and bear the UL label
- E. **Factory Inspection and Test:** The Contractor is responsible for inspection and quality control procedures. The Employer reserves the right to inspect the equipment during manufacture, factory tests and prior to shipment. Such visits to the manufacturer's plant will be at the Employer's expense. The Employer will not accept any charges for visiting the plant. The Contractor shall notify the Employer's Representative in writing 30 days before of the intended date for performing the tests. After all ANSI C37.50, C37.51, and C37.52 Production Test have been completed and any deficiencies and/or wiring errors have been corrected, the tests shall be repeated and available for witness test by the Employer's Representative or his authorized representative. The manufacturer shall supply a qualified service technician for the length of time required to perform these tests. The service technician shall assist in testing each MCC metering, control, and protective relay circuit during checkouts by the Employer's Representative. Any additional costs for this service shall be included as part of the base bid. The assembly shall be fully assembled for testing at factory. It will not be acceptable to test equipment in different factory locations.
- F. **Field Tests:** The Contractor shall perform the field tests in accordance with the Field Test Plan and Section 26 60 00 (*Field Testing Electrical Systems*).

- G. **Commissioning:** Shall conform to ^{A17}Section 01 91 00 (*Tests on Completion and Tests After Completion*). ^{A17}

END OF SECTION

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