SECTION 26 24 19 – LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide motor control centers (MCC's), complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 26 05 00 – Electrical Work, General, and Section 26 20 05 – Panel Boards and General Purpose Dry Type Transformers, apply to the WORK of this Section.

1.2 QUALITY ASSURANCE

A. General: All materials shall be inspected for compliance with Section 26 05 00 – Electrical Work, General, and shall be tested per Section 26 01 26 – Electrical Tests.

B. The MCC assembly and its components shall be of the manufacturer's latest approved design. MCCs and components shall meet the UL-845 and IEC 60439-1 requirements and bare the appropriate labels.

C. Modifications to an existing MCC shall be field evaluated to UL 845 and any other applicable standard as required by the components comprising the modified assembly. Individually listing MCC "buckets" to UL 508A is not acceptable.

D. Factory Tests: Design test reports conducted on similar assemblies at the factory testing facilities shall be submitted.

1.3 WARRANTY

A. The system warranty shall be no less than one year after initial startup and shall include all costs for repair, parts, travel and living expenses, and labor.

1.4 OPERATION AND MAINTENANCE

A. The CONTRACTOR shall submit operation and maintenance procedures for each of the new MCCs for the ENGINEER's review. The data sheets shall be supplemented by written text and shall include the following:
   1. Operating procedures.
   2. Maintenance procedures.
   3. Manufacturers' parts list, illustrations, assemblies, and diagrams.

1.5 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with MASS Section 10.05 Article 5.6.

B. Shop Drawings
   1. Enclosure NEMA rating and color
   2. Horizontal and vertical bus ampacities, voltage rating and interrupting capacity. Include materials of construction
   3. Ground bus size and material of construction
   4. Conduit entrance provisions
   5. Main incoming line entry provision (top or bottom)
   6. Control unit nameplate schedule
   7. All circuit breaker types, frames and settings
   8. All starter NEMA sizes, auxiliary contact provisions, coil voltage
   9. Relays, timers, pilot devices, control transformer VA and fuse sizes
   10. Elementary schematic ladder diagrams for each compartment. Custom schematics shall be furnished. Diagrams shall include all remote devices. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED-RESUBMIT."
   11. Short circuit rating of the complete assembly
   12. Replacement parts lists and operation and maintenance procedures
   13. Seismic design certification of the anchoring system in accordance with Section 26 05 00.
   14. Time-current curves for all protective devices

PART 2 - PRODUCTS

2.1 GENERAL

A. Devices of the same type shall be products of the same manufacturer.

B. Motor control centers shall conform to the standards for NEMA Class IIS, type B diagrams and wiring. All equipment within the MCC shall be front accessible.

C. MCC Schedule

MCC Designation	Location	Drawing

The MCC shall contain all items and accessories required for a complete working system.

2.2 DESIGN, CONSTRUCTION, AND MATERIAL REQUIREMENTS

A. Motor Control Centers (MCC)

1. Shall be 600-volt class suitable for operation on a three-phase, 60-Hz system.
2. The system operating voltage and number of wires shall be as indicated.

B. Enclosure
1. Shall be NEMA Type 1, gasketed enclosure.
2. Compartment doors shall be interlocked with compartment circuit breakers.
3. The interlock shall be fitted with a maintenance override.

C. Size and Arrangement
1. Motor control centers shall be of mechanical groupings of control center units, assembled into a lineup of control center sections. Each control section shall be sized as shown on the drawings.
2. MCCs shall be designed to not exceed the space requirements as indicated on the Contract Drawings, including spaces, spares, and future compartments. MCCs shall be subject to rejection for exceeding the lengths indicated where allotted space is critical.
3. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing the MCC provides the spares, space, and future provisions indicated.
4. All switches and circuit breakers used as switches shall be located so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6-feet 7-inches above the floor, including the height of the concrete pad.
5. All MCC sections shall be 20” deep.

D. Components
1. Busses
a. A continuous copper ground bus shall be provided with full width of the motor control center line-up.
b. The main horizontal bus shall be tin-plated copper located within an isolated compartment. The bus shall be rated as indicated on the Contract Drawings minimum, but in no instance less than the main lug or main breaker frame size.
c. The vertical bus in each section shall consist of a single tin-plated copper conductor per phase. The vertical bus shall be completely isolated and insulated, and shall extend the full height of the section wherever possible.
d. Where called for on the plans or required by the design, fully rated continuous copper neutral bus shall be provided through the control center. Lugs of appropriate capacity shall also be provided.
e. All power busses shall be braced to withstand 25,000 amps, minimum.
f. All bus compartments shall provide complete enclosure from cable termination areas.
g. The lugs on the bus shall be round.

2. Wireways
    a. A separate vertical wireway shall be provided adjacent to each vertical unit, and shall be covered by a hinged door.
    b. Each individual unit compartment shall be provided with a side barrier to permit pulling wire in the vertical wireway without disturbing adjacent unit components.
3. Distribution Section: The distribution section shall consist of molded case circuit breakers of the size indicated.

E. Cabinet
1. Structural members shall be fabricated of not less than 12-gauge steel and side and top panels and doors shall be not less than 14-gauge steel.
2. Spaces designated as "SPACE" or "EMPTY" shall include blank hinged doors and vertical bus bars.
3. Control units inside compartments shall be clearly identified with tags or stencil markings.
4. Each control unit including spares, spaces and blanks, lights, and devices shall be identified by an engraved nameplate. Identification shall include circuit number as indicated.
5. Each motor control center shall be fitted with the manufacturer's nameplate which shall include the NEMA Standard electric rating and other pertinent data, including manufacturer, sales order number, date of manufacture, and place of manufacture.
6. Fans, heat exchangers, transformers, capacitors, junction boxes, or other devices may not be mounted on the outside of the motor control center enclosure.

F. Control Wiring:
1. All control wiring shall be brought to identified terminal blocks; every cubicle containing control wiring which extends to other cubicles shall have terminal blocks. Connection made on terminal blocks and on internal devices shall be by means of locking spade-type pre-insulated terminals.
2. Control and secondary wiring shall be 600 V flame-retardant switchboard-type, minimum size No. 14 AWG, stranded tinned copper. Hinge wiring shall be extra-flexible stranding.

G. Terminal Blocks
1. Terminal blocks for all external control connections shall be 600-volt, barrier type, having a minimum rating of 20 amps with marker strips identifying all internal and external wiring.
2. Terminal blocks for current transformer secondary connections shall be of the short-circuiting type. One 4-pole block shall be used for each current transformer set.

H. Instrument Transformers
1. Current Transformers: The quantity and ratio of current transformers shall be as indicated. Current transformers shall have thermal and mechanical ratings and insulation class not less than those of the associated circuit breakers. Current

transformers shall be mounted in such a way as to provide easy access for inspection and maintenance.

2. Provide test blocks and plugs for current and potential circuits for the main breaker(s).

I. Nameplates

1. Nameplates shall be provided for front and rear face of each cubicle and for major devices thereon, such as meters, instruments, control switches, and relays.
2. Nameplates shall also be provided for major internal devices such as relays, instrument and control power transformer, fuse blocks, switches, and transformers.
3. Cubicle nameplates shall be 3-layer laminated phenolic plastic, white background, engraved to show black lettering.
4. Lettering shall be upper case as follows:
   a. 1-inch high for switchgear identification.
   b. 7/16-inch high for compartment identification.
   c. 1/8-inch high for component nameplate.
5. Thickness
   a. Nameplates 1-1/2 inches tall and smaller shall be 1/16-inch thick.
   b. Nameplates larger than 1-1/2 inches tall shall be 1/8-inch thick.
6. Edges of nameplates shall be beveled.

J. Surface Preparation, Painting, and Cleanliness

1. Metal surfaces shall be smooth and free of all foreign matter such as scale, sand, blisters, weld splatter, metal chips and shavings, oil, grease, organic matter, and rust, and shall be chemically cleaned and treated in a process which provides a phosphate coating.
2. Immediately after the treatment process, the surfaces shall be sprayed with a coating each of primer and finish paint; both shall be baked. Electrostatically deposited powder coated epoxy finishes, oven baked and 1-mil minimum thickness indoor and 2 mils minimum thickness outdoor, are acceptable.
3. All surfaces shall be finish painted light gray No. 61. The manufacturer's standard practice of double-tone finish on the low voltage switchgear section is acceptable.
4. Two spray cans of air-drying paint of each color tone shall be furnished to the ENGINEER.

2.3 FULL VOLTAGE NON-REVERSING (FVNR) MOTOR STARTERS

A. Motor starters shall be mounted in standard motor control center assemblies, arranged as indicated.

B. Each motor starter unit shall consist of a combination magnetic contactor and short circuit protective device, mounted in a completely enclosed cubicle. Short circuit protective device shall be an instantaneous, magnetic only circuit breaker, **Cutler-**

Hammer Type HMCP, or equal. All circuit breakers provided as part of a motor starter unit shall be capable of being padlocked in the open position.

C. Three-phase overload trip units shall be furnished to suit the full load current of the equipment installed. The overload unit shall be **Allen-Bradley Model E3 Plus solid-state overload relay**, or equal. Reset of the overload unit shall be possible with the unit door, or front panel, closed. Contacts and outputs on the E3 Plus unit are to be wired as required by electrical motor control diagrams.

D. The combination motor starters shall be drawout-type for size 5 and below. The fixed-type unit assembly shall be constructed so that it can be easily removed from its panel after disconnecting the wires to the terminal block and withdrawing from the primary bus. Removal of a unit assembly shall be possible without rear access and without disturbing any other unit in the motor control center.

E. Each starter unit shall have its own control power transformer. It shall have a 120-volt grounded secondary. One secondary fuse and two primary fuses shall be provided. Control power transformers shall be sized to accommodate the control devices indicated. Local control devices shall be mounted independently of the cover door. All starters shall have a local green "running" lamp. Starters shall be provided with hand/off/auto selector switches, and other devices as indicated. All cubicle control wires shall be terminated at a pull apart disconnecting terminal block at the cubicle.

F. The motor control center manufacturer shall be responsible for identifying each control wire within each motor starter unit with wrap-around permanent plastic markers. Each control wire shall be identified at both ends.

G. Full voltage motor starter units shall be NEMA Size 1 or larger. Each combination starter shall be rated for a minimum 25,000 RMS symmetrical amperes.

H. Motor starters shall be designed to NEMA ratings. Only starters designed to IEC ratings or with dual IEC/NEMA ratings are acceptable as soft-start bypass contactors.

2.4 REDUCED VOLTAGE SOLID STATE (RVSS) MOTOR STARTERS

A. RVSS starter assemblies shall be UL-listed and shall consist of
   1. an incoming power circuit breaker,
   2. a power section,
   3. logic board,
   4. protective fusing, and
   5. Paralleling bypass contactor to be energized when the starter reaches full voltage.

B. In addition, MCC installation of RVSS starters shall meet all of the applicable requirements listed in 2.3 above.

C. RVSS starters shall include adjustments for starting torque, acceleration rate control by voltage ramps, and current limit.

D. Output contactors shall be provided where indicated.

E. RVSS Starters shall be in accordance with Section 26 29 13.16 SOLID-STATE REDUCED VOLTAGE STARTERS.

2.5 VARIABLE FREQUENCY DRIVES (VFD)

A. VFD installation in MCC's shall meet all the applicable requirements listed in 2.3 above and incorporate the following:
   1. Incoming line isolation transformer
   2. Additional cooling required to operate the VFD on a continuous basis at its lest efficient speed.
   3. All incoming and outgoing conductors shall be routed away from all other power and control conductors. If separation is not feasible, VFD based power and control shall be run in metallic conduit.

B. VFD's shall be provided in accordance with SECTION 26 29 23 – VARIABLE FREQUENCY DRIVE UNITS

2.6 MAIN AND FEEDER CIRCUIT BREAKERS (480/240/208-VOLT)

A. Circuit breakers having a frame size of 150 amps or less shall be molded-case type with thermal magnetic non-interchangeable, trip-free, sealed trip units.

B. Circuit breakers with a frame size of 225 amps to 1,200 amps shall be molded case with RMS sensing electronic trip elements.

C. The interrupting capacity of all main, and feeder branch circuit breakers shall be a minimum of 25,000 RMS symmetrical amperes.

D. Circuit breaker disconnect operators shall be capable of accommodating three padlocks for locking in the "open" position.

E. Provide neutral pad or neutral bar for future 4-Wire WYE service.

2.7 TRANSFORMERS

A. All indoor transformers shall be dry-type and shall conform to or exceed the requirements of the latest applicable IEEE, NEMA and ANSI standards. Transformers rated 3 kVA and below shall be insulated with 80-degree C insulation; 5 to 30 kVA with 115-degree C insulation.

B. Transformers rated 15 kVA and above shall have 4 2-1/2 percent taps, 2 above and 2 below 480 volts. Transformers shall be enclosed within the MCC.

C. Isolation transformers shall be designed to lessen effects of transient generation into the supply power and shall act as a buffer for SCR current surges. Transformers

shall have full capacity taps 4 2-1/2 percent taps, 2 above and 2 below primary windings. Transformers shall have a 150 degree C insulation and shall be UL listed.

2.8 CONTROL DEVICES

A. All control devices shall conform to the requirements of Section 25.14 05 – Local Control Stations and Miscellaneous Electrical Devices.

B. Provide solid state type metering where indicated. Include CTs of ratios as indicated.

C. The metering equipment shall be housed in a separate compartment and shall be isolated from adjacent elements by steel or appropriate insulated barriers. See SECTION 26 36 16 MONITORING TRANSDUCERS.

2.9 DEVICENET INTERFACE

A. General
   1. The MCC shall have DeviceNet cabling as shown schematically on drawings.
   2. Each motor starter, VFD, and RVSS in the MCC shall be supplied with a means to communicate via DeviceNet,
   3. Bridges and Protocol Convertors are not permitted..
   4. All units shall be interwired and tested as a NEMA Class II MCC.

B. DeviceNet Cable
   1. The DeviceNet cable shall have an insulating rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure or raceway, i.e., no special separation, barriers, or internal conduit is required for the DeviceNet conductors.
   2. The DeviceNet cable shall be rated 8 amperes, 600-volt, Class 1.
   3. The addition or removal of a unit from the DeviceNet system shall not interrupt the operation of other units within the system.

C. DeviceNet Cable Layout
   1. A DeviceNet trunkline shall be routed through the center of the MCC line-up, behind barriers that isolate the trunkline from the unit space and wireways to prevent accidental mechanical damage during MCC installation.
   2. DeviceNet ports shall be provided in the rear of each vertical wireway to simplify installation, relocation, and addition of plug-in MCC units.
   3. The DeviceNet component within each plug-in shall be connected to one of the DeviceNet ports in the vertical wireway with cable as outlined above in Section B – DeviceNet Cable.

D. DeviceNet System Performance
   1. The DeviceNet system shall be designed to operate at 500k baud to maximize the system performance, unless precluded by the cumulative length of the trunk and drop lines. To achieve best performance, 250k baud shall be the minimum communication rate.

2. The DeviceNet system is to be qualified to communicate and perform under normal and adverse MCC electrical environments (e.g., contactor electrical operation, contactor jogging duty, and unit short circuit fault).

E. DeviceNet Units
   1. Motor Starter Units
      a. Each motor starter shall have an electronic overload relay with the following features:
         1) On-board DeviceNet communication
         2) LEDs for status indication
         3) Test/Reset button
         4) Adjustable trip class (5 to 30)
         5) General purpose I/O (minimum 4 inputs, 2 outputs), rated for 110-120 VAC or 24 VDC as specified on drawing.
         6) Protective functions with programmable trip level, warning level, time delay and inhibit window:
            a) Thermal overload
            b) Underload
            c) Jam
            d) Current imbalance
            e) Stall
            f) Phase loss
         7) Current Monitoring Functions:
            a) Individual Phase currents
            b) Average current
            c) Full load current
            d) Current to Gound
            e) Current imbalance percent
            f) Percent thermal capacity utilized
         8) Diagnostic Information:
            a) Device status
            b) Warning status
            c) Time to reset
            d) Trip status
            e) Time to overload trip
            f) History of last five trips
      b. The electronic overload relay is to be an **Allen-Bradley E3 Plus**, or equal.
      c. The module shall be wired as shown on the drawings. If additional I/O is required, when shown on the drawings, it shall utilize a DeviceNet auxiliary module having four inputs and two outputs. This module shall be **Allen-Bradley DSA Cat No. 100-DNY41R** or **100-DNY42R** depending on the voltage required

F. Programming of Parameters
   1. The DeviceNet MAC ID number (node address) shall be entered into each unit per the drawings. All other parameters may be left at the factory default setting.

2. The DeviceNet system components shall be pre-configured to operate at the appropriate baud rate.

G. Testing
1. The interwired DeviceNet MCC shall be powered up, configured, and tested in an ISO9001 facility to ensure each unit communicates properly prior to shipment.

2.10 SWITCHBOARD MATTING

A. Where called for on the drawings, Switchboard matting shall be high-voltage, 1/4-inch thick, 36 inches deep, the full width of the MCC, and shall be Model M36 as manufactured by **W.H. Salisbury & Co.**, or equal.

2.11 FACTORY TESTS

A. All motor control centers and their components shall be given manufacturer's standard electrical and mechanical production tests and inspections. The tests shall include electrical continuity check, dielectric tests for each circuit, and inspection for proper functioning of all components including controls, protective devices, metering, and alarm devices.

2.12 SPARE PARTS

A. The CONTRACTOR shall furnish the following for each MCC:
1. Three bezels of each color installed for pilot indicators
2. One dozen panel lamps
3. One dozen control fuses of each size installed

B. Spare parts shall be identified by MCC number, type, size, and manufacturer.

2.13 MANUFACTURERS, OR EQUAL

A. Motor control centers shall be **Allen-Bradley "Centerline,"** or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall install motor control centers in accordance with manufacturer's published instructions. Conduit installation shall be coordinated with manufacturer's as-fabricated drawings so that all conduit stub-ups are within the area allotted for conduit. Conduit shall be stubbed up in the section that contains the devices to which conductors are terminated.

B. The CONTRACTOR shall install new conductors from the service to the MCC, unless otherwise noted on the drawings.

C. If stored at the Site, motor control centers shall be stored in a clean, dry space. Factory wrapping shall be maintained or an additional heavy plastic cover shall be provided to protect units from dirt, water, construction debris, and traffic. Storage space shall be heated or MCC space heaters shall be energized.

D. Motor control centers shall be handled carefully to avoid damage to motor control center components, enclosure, and finish. Damage shall be repaired before installation.

3.2 INSTALLATION

A. Motor control centers shall be installed on 3-1/2-inch concrete pads. The CONTRACTOR shall be responsible for providing the concrete pads. Any existing pads are either to be removed or integrated into the new pad. No exposed concrete “lip” is to be left that presents a safety hazard. After leveling and shimming, the CONTRACTOR shall anchor motor control centers to concrete pads, and shall grout so that no space exists between the pad and support beams.

B. The CONTRACTOR shall:
   1. Torque all bus bar bolts to manufacturer's recommendations. Tighten all sheet metal and structure assembly bolts.
   2. Adjust all Motor Circuit Protector (MCP) devices to the instantaneous trip setting position recommended for the actual horsepower and full load amps of the motor. Verify that overload devices are proper for equipment installed; make necessary changes in overload devices as required for motors having power factor correcting capacitors.
   3. After equipment is installed, touch up scratches and verify that nameplate, and other identification is accurate.
   4. Provide high voltage switchboard matting in front of the MCC.

3.3 FIELD TESTS

A. Visual and mechanical inspection after installation
   1. Inspect for physical damage, proper anchorage, and grounding.
   2. Verify that the ratings of the thermal overload heaters match the motor full-load current nameplate data.
   3. Check tightness of bolted connections.

B. Electrical Tests
   1. Insulation tests
      a. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute. Test voltage and minimum acceptable resistance shall be in accordance with manufacturer's recommendations.
      b. Measure insulation resistance of each starter section phase to phase and phase to ground with the starter contacts closed and the protective device open. Test voltage and minimum acceptable resistance shall be in accordance with the manufacturer's recommendations.

c. Measure insulation resistance of each control circuit with respect to ground.
d. Record all readings and include in the Operating and Maintenance manual.

2. Undertake phase sequence test to verify phasing.
3. Verify proper operation of control logic in all modes of control.

3.4 STARTUP / FINAL

1. Contractor shall provide a Factory Representative for Startup of all of the assemblies within the MCC. Representative will work with all related trades to provide a coordinated control and power distribution system
2. After system has had any repairs/modification completed, Contractor shall clean all debris in the MCC and repair / touch up any cosmetic damage.

END OF SECTION 26 24 19