**PART 1 - GENERAL**

* 1. **SUMMARY**

1. Section Includes: Disconnect switches and motor starters for motors or equipment and connections to the motors.
2. Related Requirements:
   1. Division 01 - General Requirements.
   2. Section 03 3000: Cast-In-Place Concrete.
   3. Division 23: Heating, Ventilating, and Air Conditioning “HVAC”.
   4. Section 26 05 00: Common Work Results for Electrical.
   5. Section 26 05 13: Basic Electric Materials and Methods.
   6. Section 26 05 19: Low Voltage Wires.
   7. Section 26 05 26: Grounding and Bonding.
   8. Section 26 05 33: Raceways, Boxes, Fittings and Supports.
   9. Section 26 08 00: Electrical Systems Commissioning.
   10. Section 26 24 13: Switchboards.
   11. Section 26 24 16: Panelboards and Signal Terminal Cabinets.
3. Related Industry Standards: The most current version of the following industry standards.
4. ANSI/NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
5. California Electrical Code (CEC).
6. IEEE C57.12.28 – Standard for Pad-Mounted equipment Enclosure Integrity.
7. IEEE 551 - Recommended Practice for Calculating AC Short-Circuit Currents in Industrial and Commercial Power Systems.
8. IEEE 1584 – Performing Arc-Flash Hazard Calculations.
9. NEMA KS-1 – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum)
10. NEMA publication ICS 2.3 – Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers.
11. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
12. UL/ANSI 891 – Standard for Safety Switchboards.
13. UL-845 – Motor Control Centers.
    1. **SUBMITTALS**
14. Shop Drawings: Include a front elevation indicating dimensions, make, location and capacity of equipment, type of wiring, equipment ratings, bussing, gutters, type of mounting, anchoring bolts requirements and finish. Installation shall be in comply with CBC seismic design requirements.
15. Product Data: Submit equipment engineering data indicating make, ratings, dimensions, and catalog number for disconnect switches, motor starters, control and meter devices.
16. Fault Current, Coordination and Arc-Flash Reports: the following reports shall be prepared using SKM Systems Analysis, ETAP Powering Success, EasyPower, or equal.
17. Provide a short-circuit and coordination report signed and stamp by a California registered professional electrical engineer. Studies shall be in accordance with applicable IEEE guidelines. Submit two copies of each study for review prior to ordering and installing equipment.
18. Provide a system coordination report for main and branch circuit protective devices including transformers secondary protective devices. Study shall be recorded on log paper. The circuit protective devices shall be set based on the coordination study. A final written record of protective device settings shall be submitted.
19. Provide a complete arch-flash report based on installed equipment, and feeders’ sizes and lengths. Prepare the report in accordance with code requirements and IEEE 1584 standard. The report shall indicate trip times for protective device(s) settings, arcing fault current values, and incident energy and flash boundaries. The arc-flash report shall indicate clothing requirements for each piece of equipment.
20. Provide installation details and seismic anchorage notes.
21. Submit manufacturer's written installation instructions, including recommendations for handling, protection and storage.
22. Submit project record drawings indicating the motor control center exactly as it was installed, including wiring diagrams of components.
    1. **TECHNICAL REQUIREMENTS**
23. Motor overload protection shall be manual reset type as part of a motor starter and shall be set at not to exceed 125 percent of motor full load current rating.
24. Overload protection shall be provided for each motor exceeding 1/8 horsepower, except where indicated otherwise.
25. Overload Protection is not required when motors are of sufficient impedance to prevent overheating on failure to start (such as clock motors), and for motors provided with an approved built-in manual reset type device that is responsive to motor current and set at not to exceed 125 percent of the motor full load current rating.
26. Motor Control Center components shall be provided with nameplates. Plates shall be black and white plastic stock, with characters cut thorough black exposing white, and shall bear designation of service, feeders controlled, and fuse and/or breaker sizes.
27. Design, construction, and testing shall comply with requirements of latest CEC, UL publication UL-845, NEMA publication ICS 2.3 and applicable standards of ASA, AIEE, and NEMA.

**PART 2 - PRODUCTS**

* 1. **EQUIPMENT**

1. Motor Control Centers (MCC):
   1. Motor control centers shall be of metal-clad, free floor-standing dead-front type, totally enclosed with one or more vertical sections. Arrangement and construction shall be as indicated on Drawings.
   2. Motor control center shall be braced for the available symmetrical and asymmetrical fault currents at the MCC location.
   3. Equipment shall be completely fabricated, wired and tested at factory, and shall be shipped in sections ready for installation, complete with required assembly bolts and mounting channels. General construction shall consist of modular vertical sectioned cubicles, approximately 90 inches high and 20 inches wide. Sectional cubicles shall be bolted together to form required arrangement having the appearance of a single assembly. Cubicle sections shall be fabricated from a minimum of 12 gage P & O Mill prime sheet steel, shaped, reinforced, and welded to form a rigid structure. Sections shall contain required number of modular spaces for various starter units.
   4. Wiring gutters shall extend through cubicles with front accessible bolted filler plate covers. Connections shall be securely bolted together with corrosion-resistant plated carbon steel, of minimum grade five machine screws, secured with constant pressure type locking devices. Self-tapping screws will not be permitted.
   5. Bus bars and connections shall be copper. Vertical buses shall be rated at not less than 300 amperes and shall be placed to allow starter units to be connected by pushing into place. Bus connections shall be free fitting and bolted, with silver plated connecting areas rated at 200 amperes per square inch.
   6. Bus work bracing and support shall withstand the short circuit stresses indicated on Drawings without damage to buses or structure. Connections shall be secured bolted together with corrosion-resistant plated carbon steel, of minimum grade five machine screws, secured with constant pressure type locking devices. Self-tapping screws will not be permitted
   7. Main horizontal and vertical buses shall be made of copper and entire length shall be electrolytically silver-plated.
      1. Copper ground lugs shall be provided in incoming line vertical sections.
      2. Horizontal tin-plated copper ground buses shall be provided in each section of the motor control center. Horizontal ground bus shall run continuously throughout control center, drilled and tapped every ten inches for ¼ - 20 machine screws. RMS amperes symmetrical bus bracing shall be as indicated on Drawings.
      3. Vertical sections shall support horizontal and vertical buses, combination started units, covers and doors. Vertical sections shall be furnished with structural supporting members formed of a minimum of 13 gage hot-rolled steel.
      4. Reinforcement for structural parts shall be of ten gage steel to provide a strong, rigid assembly.
      5. Vertical sections shall be designed to accommodate bolts on units 20 inches wide and 20 inches deep.
      6. Vertical sections shall be provided with 12 inches high horizontal wireway located at bottom of sections and a six-inch horizontal wireway at top of sections in addition to the vertical wireways for each section.
      7. Busing components shall be secured bolted together with corrosion-resistant plated carbon steel, of minimum grade five machine screws, secured with constant pressure type locking devices. Self-tapping screws will not be permitted
   8. Separate control cell compartments of sizes indicated on Drawings shall be provided for future interlocking relays and transducers.
   9. Starters shall be of the bolt-on combination magnetic type, as indicated on Drawings, each with a separate hinged door. Starters shall be provided with separate overloads in each phase.
      1. Combination magnetic starters shall be circuit breaker magnetic across-the-line type, or as indicated on Drawings, and shall be furnished with suitable thermal overload elements for controlled motor.
      2. Breaker shall be bussed with copper bus bars. Covers shall be mechanically interlocked with circuit breakers to prevent opening when energized.
      3. Circuit breaker handles shall be capable of being padlocked in the off position with one to three padlocks.
      4. Each motor starter shall be furnished with a red pilot light, HOA selector switch or pushbutton station, and a control circuit transformer, unless otherwise indicated on Drawings. Control circuit transformer shall be fused.
   10. Units shall be provided with unit doors, unit support pans, unit saddles, and unit disconnect operators. Units shall be designed and constructed so that faults will be localized within compartment.
   11. Control devices and wiring of motor control centers shall be in accordance with functional wiring diagrams indicated on Drawings and requirements of controlled equipment.
   12. Motor control center wiring shall be NEMA Class 1, Type B.
   13. Motor control center shall be as manufactured by W.A. Benjamin Electric, Square D, General Electric, or equal.
2. Disconnect Switches:
   1. Heavy duty type switches shall be 240 volts or 480 volts as required, totally enclosed, externally operated, with quick-make, quick-break operating mechanism, interlock cover, and provisions for locking cover in closed position and locking switch in on and off positions. Switches shall be single throw, unless otherwise indicated or specified. Switches controlling direct current loads shall be DC rated.
   2. Switches shall be furnished with switch blades, which are fully visible in off position when switch door is open. Current carrying parts shall be plated to resist corrosion and promote cool operation.
   3. Switches shall be furnished with removable arch suppressors where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL, or other Nationally Recognized Testing Lab listed for 75 degrees C. copper wires.
   4. Switch enclosure shall be NEMA Type 1 for indoor locations and rain tight, NEMA Type 3R, rainproof for outdoor locations. NEMA Type 3R enclosures shall be manufactured from galvanized steel with gray baked enamel and shall be furnished complete with rainproof bolt on hubs. Covers shall be attached with pin type hinges. Removable closing cap types are not permitted. In kitchen area, provide disconnect switche~~r~~s in a NEMA type 4 stainless steel enclosure.
   5. Quick release latches shall be permitted only when switches are furnished tamper resistant.
   6. Switches shall be furnished with master lock pro series 6121 padlock with two 3221 keys.
   7. Switches shall be fusible or non-fusible as indicated on Drawings. Fusible switches shall accept cartridge fuses.
   8. Current rating of switches, number of poles, solid neutral facilities, and current rating of fuses shall be as indicated on Drawings.
   9. Switches shall have proper horsepower rating equal to or greater than horsepower of motor controlled. Only lower horsepower rating of dual rated switches will be permitted as a switch rating. Switches shall accept Class H, Class J, and Class R fuses.
   10. Padlocking device shall lock operating handle and cover with one padlock regardless of on or off position. Furnish a minimum of two padlocks and two keys with each switch. Master lock pro series padlock, keyed 3221.
   11. Furnish one spare fuse for each fusible disconnect switch installed. Spare fuses shall be same type and rating as those installed.
   12. Switches shall be heavy duty type, as manufactured by Square D, General Electric, Westinghouse or equal. Switches shall be UL listed and shall comply with NEMA Standard KS-1.
3. Motor Starters:
   1. Motor starters shall be AC magnetic across-line starters unless otherwise indicated on Drawings.
      1. Motor starters shall be furnished with manual reset thermal overload protective devices including heating elements.
      2. Starters shall be furnished in a NEMA Type 1, NEMA Type 3R or other type of enclosure as indicated on Drawings.
      3. Starters shall be furnished with HOA selector switches or pushbuttons, as indicated on Drawings.
      4. NEMA size, voltage rating, number of poles, and special features shall be as indicated on Drawings.
      5. Horsepower rating of each starter shall be equal to or greater than motor horsepower.
      6. Starters for motor circuits rated at 208 volts and above shall be provided with a control circuit transformer, having a 120-volt secondary.
      7. Combination magnetic starters are permitted.
      8. Three-phase starters shall be furnished with three-element protection.
   2. Manual across-line starters shall be furnished with manual reset thermal overload protective devices, including heating elements, start-stop-reset device or H.O.A. switch as indicated on Drawings, operable from front.
      1. Enclosure shall be NEMA Type 1 for indoor installation and NEMA Type 3R for outdoor installation or as indicated on the Drawings.
      2. NEMA size, voltage rating and number of poles shall be determined by motor horsepower, voltage and phase indicated on Drawings.
      3. Horsepower rating of each starter shall be equal to or greater than motor horsepower.
      4. Combination manual starters are permitted.
   3. Thermal switch starters shall be tumbler type with plaster ears, binding screws for wiring, standard size composition cups with fully enclose mechanism, and designed to fit standard outlet boxes.
      1. Thermal switches shall be fractional horsepower motor starters with thermal overload protective devices including heating elements, and with handle providing on-off-reset control.
      2. Horsepower rating, voltage rating, and number of poles shall be determined from motor horsepower and voltage indicated on Drawings.
      3. Switches shall be key operated where so indicated on Drawings.
      4. Furnish one key with each key type switch.
      5. Horsepower rating of each switch shall be equal to or greater than motor horsepower.
   4. Relays furnished for directly controlling motors shall be installed in NEMA Type 1 enclosure for indoor installations and NEMA Type 3R for outdoor installations, unless otherwise indicated on drawings.
      1. Relays shall be horsepower rated.
      2. Relay size, voltage rating and number of poles shall be determined from motor horsepower and voltage indicated on Drawings.

**PART 3 - EXECUTION**

* 1. **INSTALLATION**

1. Motor control centers installed outdoors, or below grade, shall be installed on a concrete pad as specified in Section 03 3000 – Cast-In-Place Concrete, and as indicated on Drawings.
2. Motor control centers shall be anchored to concrete slab. Anchor bolts for freestanding equipment shall be designed to meet CBC seismic requirements. Provide structural drawings for Architect review prior to start of construction.
3. Equipment shall be securely fastened to the mounting surface.
4. Equipment shall be located so that it is readily accessible and not exposed to physical damage.
5. Provide code required working space around the equipment.
6. Equipment installed outdoors shall be specifically approved for wet locations and shall be installed in a weatherproof NEMA–3R enclosure.
7. Equipment enclosure shall be grounded to comply with Article 250 of the California Electrical Code.
8. Conduits shall be installed in a manner that prevents moisture or water from entering and accumulating within the equipment enclosure.
9. Lugs shall be suitable and permitted for installation with the conductor being connected.
10. Conductor lengths shall be maintained to a minimum within the wiring space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.
11. Maintain the required bending radius of conductors inside the cabinet.
12. Distribute and arrange conductors neatly within the equipment space.
13. Tightening of wire lugs or any conductor connections shall be performed in the presence of the Project Inspector. Torque values shall be those recommended by manufacturer.
14. Remove shipment blocks from component devices.
15. Manually exercise switches and circuit breakers to verify they operate freely.
16. Remove debris from equipment interior.
17. Follow manufacturer’s instructions for installation.
18. Installation in corrosive environments such as boiler rooms, pool equipment, and other similar spaces is not allowed.
19. The contractor shall be responsible for the testing of bolted electrical connections, perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground for one minute in accordance with requirements stated in NETA-ATS 2007 table 100.1. or latest version, test shall be performed in the following manner:
    * + 1. Utilize the services of an approved independent testing laboratory to perform megger time-resistance insulation testing of bussing, circuit breakers and/or fused switches. The fused switches shall be equipped with fuses or temporary jumpers in place of fuses. Breaker and fused switches shall be tested in the closed position. No wiring shall be connected to the line or load side of the motor control center during testing.
20. Provide calibration program records to assure the testing instruments to be within rated accuracy. The test equipment accuracy shall be in accord with the requirements stated by the National Institute of Standards and Technology (NIST).
21. Test equipment shall be provided with a label stating the date of last calibration. As a minimum the equipment shall have been calibrated within the past 12 months.
22. Test reports shall include the following:
    * 1. Identification of the testing organization.
      2. Equipment identification.
      3. Ambient conditions.
      4. Identification of the testing technician.
      5. Summary of project.
      6. Description of equipment being tested.
      7. Description of tests.
      8. Test results.
      9. Analysis, interpretation and recommendations.
23. Perform test in the presence of the Project Inspector.
24. During testing, provisions shall be made to prevent damage to any solid-state components, or electronic equipment such as TVSS equipment that may be tied onto panel bussing.
    1. **PROTECTION**
25. Protect the Work of this section until Substantial Completion.
    1. **CLEANUP**
26. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

END OF SECTION