PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of the distribution switchboards.

1.2 RELATED WORK

//A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for Seismic Restraint for Nonstructural Components.//

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for Personnel Safety and to provide a low impedance path for possible fault currents.

E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and outlet boxes.

F. Section 26 27 13, ELECTRIC METERING: For revenue metering devices integral to the distribution switchboards.//

G. Section 26 43 13, TRANIENT-VOLTAGE SURGE SUPPRESSION: TVSS equipment for distribution switchboards.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Distribution switchboards shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Tests shall be conducted as per NEMA PB 2 and UL 891. Factory tests shall be certified.

B. The following additional tests shall be performed:
1. Verify that circuit breaker sizes and types correspond to drawings and coordination study.
2. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data.
3. Exercise all active components.
4. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer’s published data.
5. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable, or as required if solid-state components or control devices cannot tolerate the applied voltage.
6. If applicable, verify correct function of control transfer relays located in the switchboard with multiple control power sources.
7. Perform phasing checks on double-ended or dual-source switchboards to insure correct bus phasing from each source.

C. Furnish four (4) copies of certified manufacturer's factory test reports to the Resident Engineer/COTR prior to shipment of the switchboards to ensure that the switchboards have been successfully tested as specified.

//D. The Government shall have an option to witness the factory tests. All expenses of the Government Representative's trips to witness the testing will be paid by the Government. Notify the Resident Engineer/COTR not less than 30 days prior to making tests at the factory.//

1.5 SUBMITTALS
Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:
A. Shop Drawings:
1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, sectional views, bus work, circuit breaker frame sizes, trip and short-circuit rating, long-time, short-time, instantaneous and ground fault settings, coordinated breaker and fuse curves, accessories, and device nameplate data.
3. Show the size, ampere-rating, number of bars per phase and neutral in each bus run (horizontal and vertical), bus spacing, equipment ground bus, and bus material.

B. Manuals:
1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
   a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.
   b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnection between the items of equipment.
   c. Provide a clear and concise description of operation, which gives, in detail, the information required to properly operate the equipment.
   d. Approvals will be based on complete submissions of manuals together with shop drawings.
2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manuals to the Resident Engineer/COTR.
   a. The manuals shall be updated to include any information necessitated by shop drawing approval.
   b. Complete "As Installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.
   c. Show all terminal identification.
   d. Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
   e. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
   f. Furnish manuals in loose-leaf binder or manufacturer's standard binder.

C. Certifications:
1. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer/COTR:
   a. Certification by the Contractor that the assemblies have been properly installed, adjusted and tested, including circuit breakers settings.
   b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the assemblies.
1.6 APPLICABLE PUBLICATIONS

Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

A. Institute of Engineering and Electronic Engineers (IEEE):
   C57.13-08 ............... Instrument Transformers
   C62.41-95 ............... Surge Voltage in Low Voltage AC Power Circuits
   C62.45-02 ............... Surge Testing for Equipment connected to Low-Voltage AC Power Circuits

B. National Electrical Manufacturer's Association (NEMA):
   PB-2-06 ................... Dead-Front Distribution Switchboards.
   PB-2.1-07 ............... Instructions for Proper Handling, Installation, Operation, and Maintenance of Switchboards
   AB-1-02 ................... Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures

C. National Fire Protection Association (NFPA):
   70-08 ..................... National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):
   67-06 ..................... Panelboards
   489-02 ................... Molded Case Circuit Breakers and Circuit Breakers Enclosures
   891-05 ................... Dead-Front Switchboards
   1283-09 .................. Electromagnetic Interference Filters
   1449-06 .................. Transient Voltage Surge Suppressors

PART 2 - PRODUCTS

2.1 GENERAL

A. Switchboards shall be in accordance with UL, NEMA, NEC, IEEE, and as shown on the drawings.

B. Switchboards shall be provided complete, ready for operation including, but not limited to housing, buses, circuit breakers, instruments and related transformers, fuses, and wiring.

C. Switchboard dimensions shall not exceed the dimensions shown on the drawings.

D. Manufacturer’s nameplate shall include complete ratings of switchboard in addition to the date of manufacture.

SPEC WRITER NOTES: Select the Type I or Type II switchboard as required for the particular project. Based on the short circuit and coordination study for the project use fully rated circuit breakers.
2.2 BASIC ARRANGEMENT

A. Type I: Switchboard shall be front accessible with the following features:
1. Device mounting:
   a. Main breaker: Individually mounted and compartmented or group mounted with feeder breakers.
   b. Feeder breakers: Group mounted.
2. Section alignment: As shown on the drawings.
3. Accessibility:
   a. Main section line and load terminals: Front and side.
   b. Distribution section line and load terminals: Front.
   c. Through bus connections: Front and end.
4. Bolted line and load connections.
5. Full height wiring gutter covers for access to wiring terminals.
   SPEC WRITER NOTES: Fill in the short circuit ratings required below.
6. Short Circuit Current Rating: // _______ // amperes rms symmetrical, minimum, or as shown on the drawings, whichever is higher.

B. Type II: Switchboard shall be rear accessible with the following features:
1. Device mounting:
   a. Main breaker: Individually mounted and compartmented.
   b. Feeder breakers: Individually mounted and compartmented.
2. Section alignment: As shown on drawings.
3. Accessibility:
   a. Main section line and load terminals: Rear.
   b. Distribution section line and load terminals: Rear.
   c. Bus connections: Rear.
4. Short Circuit Current Rating: as shown on the drawings, whichever is higher.

2.3 HOUSING

A. Provide a completely enclosed, free standing, steel enclosure not less than the gage required by the ANSI and UL standards. The enclosure is to consist of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw on sheet steel plates.
B. Provide ventilating louvers where required to limit the temperature rise of current carrying parts. All openings shall be protected against entrance of falling dirt, water, or foreign matter.
C. Enclosure shall be thoroughly cleaned, phosphate treated, and primed with rust-inhibiting paint. Final finish coat to be the manufacturers standard gray. Provide a quart of finish paint for touch-up purposes.

2.4 BUSES
A. General: Buses shall be arranged for 3 phase, 4 wire distribution. Main phase buses (through bus), full size neutral bus, and ground bus shall be full capacity the entire length of the switchboard. Provide for future extensions by means of bolt holes or other approved method. Brace the bus to withstand the available short circuit current at the particular location and as shown on the drawings. No magnetic material shall be used between buses to form a magnetic loop.

B. Material and Size: Buses and connections shall be hard drawn copper of 98 percent conductivity. Bus temperature rise shall not exceed 65 degrees C (149 degrees F). Section busing shall be sized based on UL and NEMA Switchboard Standards.

C. Bus Connections: All contact surfaces shall be copper. Provide a minimum of two plated bolts per splice. Where physical bus size permits only one bolt, provide a means other than friction to prevent turning, twisting or bending. Torque bolts to the manufacturer's recommended values.

D. Neutral Bus: Provide bare or plated bus and mount on insulated bus supports. Provide neutral disconnect link to permit isolation of neutral bus from the common ground bus and service entrance conductors.

E. Ground Bus: Provide an uninsulated 6 mm by 50 mm (1/4 inch by 2 inch) copper equipment ground bus bar sized per UL 891 the length of the switchboard and secure at each section.

SPEC WRITER NOTES: Include paragraph F only if the neutral is to be grounded at this point.

//F. Main Bonding Jumper: Connect an uninsulated 6mm by 50mm (1/4 inch by 2 inch) copper bus between the neutral and ground buses to establish the system common ground point.//

2.5 INTERNALLY INTEGRATED SURGE PROTECTIVE DEVICES
A. Integral Surge Suppressor:
1. SPD (Surge Protective Devices) shall be Component Recognized and listed in accordance with UL 1449 Second Edition to include Section 37.3 highest fault category testing on devices intended for service entrance use. SPD shall also be UL 1283 listed.
2. SPD shall be UL 67 listed, installed by and shipped from the electrical distribution equipment manufacturer’s factory.
3. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, in WYE systems, and L-L, L-G in DELTA systems.

4. SPD shall be modular in design. Each mode shall be fused with a 200kAIC UL recognized surge rated fuse and incorporate a thermal cutout device.

5. SPD shall be integrally mounted to the bus bars of the switchboard.

6. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided as well.

7. SPD shall meet or exceed the following criteria:
   a. Maximum surge current capability (single pulse rated) per phase shall be:
      1) Service Entrance Switchboard 250 kA.
      2) Distribution Panelboards 160 kA
      3) Branch Panelboards 160 kA
   b. UL 1449 Second Edition Listed and Recognized Component Suppression Voltage Ratings (SVR’s) for Service Entrance and Distribution Location equipment shall not exceed the following:
   c. Voltage Let-Thru Values for Solidly Grounded Systems:

<table>
<thead>
<tr>
<th>VOLTAGE</th>
<th>L-N</th>
<th>L-G</th>
<th>N-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>208Y/120</td>
<td>400V</td>
<td>400V</td>
<td>400V</td>
</tr>
<tr>
<td>480Y/277</td>
<td>800V</td>
<td>800V</td>
<td>800V</td>
</tr>
</tbody>
</table>

8. SPD shall have a minimum EMI/RFI filtering of -50Db at 100 kHz with an insertion ration of 50:1 using MIL-STD-220A methodology.

9. SPD shall have the following diagnostic features: transient counter, status lights on each phase, and one set of 1 NO and 1 NC auxiliary dry contacts for alarming.

10. SPD shall have a warranty for a period of five years, incorporating unlimited replacements of suppressor parts if transients destroy them during the warranty period. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

2.6 NAMEPLATES AND MIMIC BUS

A. Nameplates: For Normal Power system, provide laminated black phenolic resin with white core with 12mm (1/2 inch) engraved lettered nameplates
next to each circuit breaker. For Essential Electrical System, provide laminated red phenolic resin with white core with 12mm (1/2 inch) engraved lettered nameplates next to each circuit breaker. Nameplates shall indicate equipment served, spaces, or spares in accordance with one line diagram shown on drawings. Nameplates shall be mounted with plated screws on front of breakers or on equipment enclosure next to breakers. Mounting nameplates only with adhesive is not acceptable.

B. Mimic Bus: Provide an approved mimic bus on front of each switchboard assembly. Color shall be black for the Normal Power system and red for the Essential Electrical System, either factory-painted plastic or metal strips. Plastic tape shall not be used. Use symbols similar to one line diagram shown on drawings. Plastic or metal strips shall be mounted with plated screws.

2.7 PROVISION FOR FUTURE

Where "provision for", "future", or "space" is noted on drawings, the space shall be equipped with bus connections to the future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and physical clearance. Provide buses for the ampere rating as shown for the future device.

2.8 CONTROL WIRING

Control wiring shall be 600 volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected. Wiring across hinges and between shipping units shall be Class C stranded. Size in accordance with NEC. Provide control circuit fuses.

SPEC WRITER NOTES: Show in schedule on drawings, breaker frame size, trip, voltage, interrupting rating, time band and pick-up settings.

2.9 MAIN CIRCUIT BREAKERS

A. Type I Switchboard: Provide UL listed and labeled molded case circuit breakers in accordance with NEC and as shown on the drawings. Circuit breakers shall be the solid state adjustable trip type.

1. Trip units shall have field adjustable tripping characteristics as follows:
   a. Ampere setting (continuous).
   b. Long time band.
   c. Short time trip point.
   d. Short time delay.
   e. Instantaneous trip point.
   f. Ground fault trip point.
   g. Ground fault trip delay.
2. Trip settings shall be as indicated on the drawings. Final settings shall be as shown on the electrical system protective device study.
3. Breakers, which have same rating, shall be interchangeable with each other.

SPEC WRITER NOTES: Select power type or molded case circuit breaker as required for the particular project.

B. Type II Switchboard:
//1. Provide UL listed and labeled molded case circuit breakers in accordance with NEC and as shown on the drawings. Circuit breakers shall be the solid state adjustable trip type.
   a. Trip units shall have field adjustable tripping characteristics as follows:
      1) Ampere setting (continuous).
      2) Long time band.
      3) Short time trip point.
      4) Short time delay.
      5) Instantaneous trip point.
      6) Ground fault trip point.
      7) Ground fault trip delay.

   b. Trip settings shall be as indicated on the drawings. Final settings shall be as shown on the electrical system protective device study.
   c. Breakers, which have same rating, shall be interchangeable with each other. //

SPEC WRITER NOTES: Show breaker frame size, trip, voltage, interrupting rating, time bands and pick-up settings on the drawings.

2.10 FEEDER CIRCUIT BREAKERS

A. Provide UL listed and labeled molded case circuit breakers, in accordance with the NEC, as shown on the drawings, and as herein specified.

SPEC WRITER NOTES: Select the desired non-adjustable or adjustable circuit breaker paragraph below.

//B. Non-adjustable Trip Molded Case Circuit Breakers:
1. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame size or less. Magnetic trip shall be adjustable from 3X to 10X for breakers with 600 ampere frame size and higher. Factory setting shall be LOW unless otherwise noted.
2. Breaker features shall be as follows:
   a. A rugged, integral housing of molded insulating material.
   b. Silver alloy contacts.
   c. Arc quenchers and phase barriers for each pole.
   d. Quick-make, quick-break, operating mechanisms.
   e. A trip element for each pole, thermal magnetic type with long time delay and instantaneous characteristics, a common trip bar for all poles and a single operator.
   f. Electrically and mechanically trip free.
   g. An operating handle which indicates ON, TRIPPED and OFF positions.
   h. Line and load connections shall be bolted.
   i. Interrupting rating shall not be less than the maximum short circuit current available at the line.
   j. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open. //

C. Adjustable Trip Molded Case Circuit Breakers:
1. Provide molded case, solid state adjustable trip type circuit breakers.
2. Trip units shall have field adjustable tripping characteristics as follows:
   a. Ampere setting (continuous).
   b. Long time band.
   c. Short time trip point.
   d. Short time delay.
   e. Instantaneous trip point.
   f. Ground fault trip point.
   g. Ground fault trip delay.
3. Trip settings shall be as indicated on the drawings. Final settings shall be shown on the electrical system protective device study.
4. Breakers, which have same rating, shall be interchangeable with each other. //

PART 3 – EXECUTION

3.1 INSTALLATION
A. Install the switchboard in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
B. Anchor switchboard to the slab with plated 12.5MM (1/2 inch) minimum anchor bolts, or as recommended by the manufacturer.
C. In seismic areas, switchboard shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed. //
DISTRIBUTION SWITCHBOARDS

SPEC WRITER NOTES: Mounting slab connections may have to be given in detail depending on the requirements for the seismic zone in which the equipment is located. Include construction requirements for concrete slab only if slab is not detailed in drawings.

D. Exterior Location. Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 200MM (8 inches) thick, reinforced with a 150MM (6 by 6 inch) No. 6 mesh placed uniformly 100MM (4 inches) from the top of the slab. Slab shall be placed on a 150MM (6 inch) thick, well-compacted gravel base. The top of the concrete slab shall be approximately 100MM (4 inches) above the finished grade. Edges above grade shall have 12.5MM (1/2 inch) chamfer. The slab shall be of adequate size to project at least 200MM (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75MM (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

E. Interior Location. Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 100MM (4 inches) thick. The top of the concrete slab shall be approximately 100MM (4 inches) above finished floor. Edges above floor shall have 12.5MM (1/2 inch) chamfer. The slab shall be of adequate size to project at least 200MM (8 inches) beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 75MM (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:

1. Visual and Mechanical Inspection
   a. Compare equipment nameplate data with specifications and approved shop drawings.
   b. Inspect physical, electrical, and mechanical condition.
   c. Confirm correct application of manufacturer's recommended lubricants.
   d. Verify appropriate anchorage, required area clearances, and correct alignment.
e. Verify that circuit breaker sizes and types correspond to approved shop drawings.
f. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
g. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
h. Clean switchboard.
i. Inspect insulators for evidence of physical damage or contaminated surfaces.
j. Verify correct shutter installation and operation.
k. Exercise all active components.
l. Verify the correct operation of all sensing devices, alarms, and indicating devices.
m. If applicable, verify that vents are clear.
n. If applicable, inspect control power transformers.

2. Electrical Tests
   a. Perform insulation-resistance tests on each bus section.
   b. Perform overpotential tests.
   c. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
   d. Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

3.3 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the switchboard is in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device.

3.4 INSTRUCTION

Furnish the services of a factory certified instructor for one 4 hour period for instructing personnel in the operation and maintenance of the switchboard and related equipment on the date requested by the Resident Engineer/COTR.