

SECTION 26 13 13
MEDIUM-VOLTAGE CIRCUIT BREAKER SWITCHGEAR

SPEC WRITER NOTE: Delete between //---// if not applicable to project. Also delete any other item or paragraph not applicable in the section, and renumber the paragraphs.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, connection, and testing of medium-voltage circuit breaker switchgear, indicated as switchgear in this section.

1.2 RELATED WORK

- //A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete equipment pads.//
- //B. Section 09 06 00, SCHEDULE FOR FINISHES: Finishes for outdoor switchgear.//
- //C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint for nonstructural components.//
- D. Section 25 10 10, ADVANCED UTILITY METERING: Electric meters installed in switchgear.
- E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.
- F. Section 26 05 13, MEDIUM-VOLTAGE CABLES: Medium-voltage cables and terminations.
- G. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductors.
- H. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- I. Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY: Short circuit and coordination study, and requirements for a coordinated electrical system.
- //J. Section 26 23 13, GENERATOR PARALLELING CONTROLS: For switchgear used as part of a generator paralleling system.//
- K. Section 26 13 16, MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHES: Medium-voltage fusible interrupter switches.

L. Section 26 24 16, PANELBOARDS: For panelboards integral to the switchgear.

1.3 QUALITY ASSURANCE

A. Quality Assurance shall be in accordance with Paragraph, QUALIFICATIONS (PRODUCTS AND SERVICES) in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Factory Tests shall be required.

B. Factory Tests shall be in accordance with Paragraph, MANUFACTURED PRODUCTS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:

1. Switchgear shall be tested, with the circuit breakers in the connected position in their cubicles. Tests shall be in accordance with NEMA C37.54 and C37.55, and IEEE C37.09. Factory tests shall be certified, and shall include the following tests:
 - a. Design tests.
 - b. Production tests.
 - c. Conformance tests.
2. The following additional tests shall be performed:
 - a. Verify that circuit breaker sizes and types correspond to drawings, and the Overcurrent Protective Device Coordination Study.
 - b. Verify that current and voltage transformer ratios correspond to drawings.
 - c. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 - //d. Confirm correct operation and sequencing of key-type mechanical interlock systems for multiple circuit breakers by attempting closure on locked-open devices, and attempting to open locked-closed devices, and making key exchange with devices operated in off-normal positions.//
 - e. Verify correct barrier and shutter installation and operation.
 - f. Exercise all active components.
 - g. Inspect indicating devices for correct operation.
 - h. Perform an insulation-resistance test, phase to ground, on each bus section, with phases not under test grounded, in accordance with manufacturer's published data.

- i. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 V DC for 300-volt rated cable and 1000 V DC for 600-volt rated cable, or as required if solid-state components or control devices cannot tolerate the applied voltage.
- j. If applicable, verify correct function of control transfer relays located in the switchgear with multiple control power sources.
- k. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.

1.5 SUBMITTALS

- A. Submit in accordance with Paragraph, SUBMITTALS in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, and the following requirements:
 1. Shop Drawings:
 - a. Switchgear shop drawings shall be submitted simultaneously with or after the Overcurrent Protective Device Coordination Study.
 - b. Submit sufficient information to demonstrate compliance with drawings and specifications.
 - c. Prior to fabrication of switchgear, submit the following data for approval:
 - 1) Complete electrical ratings.
 - 2) Circuit breaker sizes.
 - 3) Interrupting ratings.
 - 4) Safety features.
 - 5) Accessories and nameplate data.
 - 6) Switchgear one line diagram, showing ampere rating, number of bars per phase and neutral in each bus run (horizontal and vertical), bus spacing, equipment ground bus, and bus material.
 - 7) Elementary and interconnection wiring diagrams.
 - 8) Technical data for each component.
 - 9) Dimensioned exterior views of the switchgear.
 - 10) Dimensioned section views of the switchgear.
 - 11) Floor plan of the switchgear.
 - 12) Foundation plan for the switchgear.
 - 13) Provisions and required locations for external conduit and wiring entrances.
 - 14) Approximate design weights.

SPEC WRITER NOTE: Include the following paragraph for projects in seismic areas of moderate-high, high and very high seismicities as listed in Table 4 of VA Handbook H-18-8, Seismic Design Requirements. Coordinate with the structural engineer.

- //d. Certification from the manufacturer that representative switchgear has been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.//
 - //e. Obtain and submit written approval from the electric utility company, that the equipment and material interface with the customer meets with their requirements and approval.//
2. Manuals:
- a. 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.
 - 1) Three-line diagrams showing device terminal numbers.
 - 2) Schematic signal and control diagrams, with all terminals identified, matching terminal identification in the switchgear.
 - 3) Include information for testing, repair, troubleshooting, assembly, disassembly, and factory recommended/required periodic maintenance procedures and frequency.
 - 4) Provide a replacement and spare parts list. Include a list of tools and instruments for testing and maintenance purposes.
 - b. If changes have been made to the maintenance and operating manuals originally submitted, submit updated maintenance and operating manuals two weeks prior to the final inspection.
3. Test Reports:
- a. Submit certified factory design and production test reports for approval.
 - b. Two weeks prior to the final inspection, submit certified field test reports and data sheets.
4. Certifications: Two weeks prior to final inspection, submit four copies of the following.

- a. Certification by the manufacturer that switchgear conforms to the requirements of the drawings and specifications.
- b. Certification by the Contractor that switchgear has been properly installed, adjusted, and tested.

1.6 APPLICABLE PUBLICATIONS

- A. 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 the basic designation only.
- B. Institute of Electrical and Electronics Engineers (IEEE):
 - C37.04-18.....Rating and Requirements for AC High-Voltage
Circuit Breakers
 - C37.06.1-17.....Recommended Practice for Preferred Ratings for
High-Voltage AC Circuit Breakers
 - C37.09-18.....Test Procedure for AC High-Voltage Circuit
Breakers with Rated Max Voltage Above 1000 V
 - C37.2-08.....Electrical Power System Device Function
Numbers, Acronyms, and Contact Designations
 - C37.20.2-15.....Metal-Clad Switchgear
 - C37.23-15.....Metal Enclosed Bus
 - C37.90-11.....Relays and Relay Systems Associated with
Electric Power Apparatus
 - C57.13-16.....Requirements for Instrument Transformers
 - C62.11-20.....Metal-Oxide Surge Arresters for AC Power
Circuits (>1 kV)
- C. International Code Council (ICC):
 - IBC-21.....International Building Code
- D. National Electrical Manufacturers Association (NEMA):
 - C37.54-20.....Indoor Alternating Current High-Voltage Circuit
Breakers Applied as Removable Elements in
Metal-Enclosed Switchgear - Conformance Test
Procedures
 - C37.55-20.....Medium-Voltage Metal-Clad Switchgear Assemblies
- Conformance Test Procedures
 - C37.57-10.....Switchgear-Metal-Enclosed Interrupter
Switchgear Assemblies - Conformance Testing
 - SG 4-13.....Alternating-Current High-Voltage Circuit
Breakers

- E. National Fire Protection Association (NFPA):
 - 70-23.....National Electrical Code (NEC)

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Switchgear shall be in accordance with IEEE, NEMA, NFPA, as shown on the drawings, and have the following features:
 - 1. Switchgear shall be a complete, grounded, continuous-duty, integral assembly, metal clad, dead-front, dead-rear, self-supporting, // indoor type switchgear assembly, // tamperproof, weatherproof, outdoor type switchgear assembly with metal housing and a walk-in protected aisle //. Incorporate devices shown on the drawings and all related components required to fulfill operational and functional requirements.
 - 2. Ratings shall not be less than shown on the drawings. Short circuit ratings shall not be less than // 250 // 350 // 500 // 750 // 1000 // MVA.
 - 3. Switchgear shall conform to the arrangements and details shown on the drawings.
 - //4. Coordinate all requirements with the electric utility company supplying electrical service to the switchgear. The incoming electric utility feeder and revenue metering installation shall conform to the requirements of the electric utility company.//
 - //5. Key-type mechanical interlocks for multiple circuit breakers shall be provided as shown on the drawings.//
 - 6. Switchgear shall be assembled, connected, and wired at the factory so that only external circuit connections are required at the construction site. Split the structure only as required for shipping and installation. Circuit breakers and accessories shall be packaged and shipped separately. Packaging shall provide adequate protection against rough handling during shipment.
 - 7. All non-current-carrying parts shall be grounded per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS, for additional requirements.

2.2 HOUSING

- A. Shall have the following features:
 - 1. Frames and enclosures:

- a. The assembly shall be braced with reinforcing gussets using bolted connections to assure rectangular rigidity.
 - b. The enclosure shall be steel, leveled, and not less than the gauge required by applicable publications.
 - c. Die-pierce the holes for connecting adjacent structures to insure proper alignment, and to allow for future additions.
 - d. All bolts, nuts, and washers shall be //zinc-plated//cadmium-plated// steel.
2. Cubicles:
- a. An individual cubicle shall be supplied for each circuit breaker and each future circuit breaker as shown on the drawings. Cubicles shall be provided with isolated wireways for control wiring between devices.
 - 1) Compartment each cubicle so that the circuit breaker, buses, and cable terminations are in separate compartments with steel partitions or barriers of approved and properly installed insulation.
 - 2) Each cubicle furnished with a circuit breaker (active or spare) shall be fully equipped as noted on drawings and specified below.
 - 3) Each cubicle noted as space for future circuit breaker shall be fully equipped for positioning and connecting the breakers. Provide all equipment required to implement the future breaker installation, except the relays and meters on the cubicle doors and the associated current transformers.
 - b. Conveniently locate test blocks within each cubicle for circuit breaker wiring connections.
3. Auxiliary compartments:
- a. Cubicles shall be provided for auxiliaries, metering, and transition or termination sections as required by the manufacturer, and as shown on drawings. Cubicles shall be provided with isolated wireways for control wiring between devices.
4. Cubicle doors:
- a. The doors shall permit convenient removal and interchanging of the circuit breakers between cubicles. The doors shall be capable of a swing approaching 180 degrees and shall be provided with intermediate doorstops.

- b. Each door shall include suitable handles and padlocking provisions. Concealed or semi-concealed hinges shall be provided to attach the doors. Weld the hinges to the equipment structure and to the cubicle doors.
- c. The following equipment shall be mounted on the door of circuit breaker cubicles:
 - 1) A breaker control switch.
 - 2) Breaker-position-indicator lamps.
 - 3) Protective relays and/or metering as indicated on the drawings or other sections of the specifications.
 - 4) Any additional components indicated on the drawings.

SPEC WRITER NOTE: Include the following paragraphs for outdoor switchgear.

//B. Walk-in Protected Enclosure:

1. Where indicated on the drawings, provide an outdoor, weatherproof, protected walk-in aisle enclosure, fabricated and coordinated with the switchgear to form an integral enclosure. //Enclosure shall be seismically rated for the seismic zone in which it is installed.//
2. The entire length of the protected aisle shall be wide enough to permit two circuit breakers to pass side by side conveniently.
3. Adequate space shall be provided for convenient installation, operation and maintenance of the batteries, battery charger, circuit breaker test equipment, and the revenue metering equipment. The aisle area shall be not less than shown on the drawings.
4. The entire space within the enclosure shall be provided with a steel floor adequately reinforced to allow the circuit breakers to be interchanged and serviced without causing the floor to deflect. The entire floor shall be at the same level.
5. The roof of the enclosure shall slope to allow for adequate run-off of moisture.
6. The entire area between the floor and foundation, including feeder conduits, shall be enclosed by structural steel or steel sheets.

SPEC WRITER NOTE: The A/E shall specify heating, air conditioning, and ventilation equipment suitable for the installed environmental conditions.

7. The enclosure shall include proper air conditioning, heating, and/or ventilation equipment as shown on the drawings or as recommended by the manufacturer. All ventilation openings shall be provided with

suitable filters and rodent screens. The air conditioning and ventilation equipment shall limit the temperature rise to 6 degrees C (10 degrees F) above ambient, but no higher than 40 degrees C (104 degrees F).

- //8. Provide wind-driven rain and wind-driven missile impact protection suitable for hurricane-prone regions.//
9. Enclosure doors:
- a. Locate a door wide enough to allow a circuit breaker to pass at each end of the protected aisle.
 - b. The doors shall be safety type, steel with concealed or semi-concealed hinges for attachment. Weld the hinges to the equipment structure.
 - c. Provide the doors with panic hardware on the inside and grab handle on the exterior. A latch bolt controlled by a key cylinder shall lock the door from the outside. Key the cylinder as directed by the //Resident Engineer// //COR// and as coordinated with the electric utility company, if applicable.
10. Equipment rear doors:
- a. Provide suitable weatherproof type doors on the rear of the switchgear enclosure for each cubicle. Attach the doors by concealed or semi-concealed hinges. Weld the hinges to the enclosure and to the cubicle doors. Provide each door with a three-point latching and locking assembly and provisions for padlocking.
 - b. The doors shall be capable of a swing approaching 180 degrees and shall be provided with intermediate doorstops.
11. Cubicle heaters:
- a. Install a thermostatically controlled electric strip heater within each circuit breaker cubicle and cable termination compartment to limit excessive humidity during adverse weather conditions. Thermostat shall be set and marked with manufacturer's recommended setting.
 - b. Heater and associated control wiring shall be pre-wired at the factory. Properly fuse the wiring and protect to prevent terminal overheating.
12. Lighting:
- a. Provide 1200 mm (4 feet), two-lamp, ceiling mounted, LED fixtures, 2400 mm (8 feet) on centers over the front aisle, with

fixtures parallel to the switchgear. Lamps shall be LED T8-23 watt each, with LED driver and LED emergency battery packs. LED emergency battery packs shall maintain illumination for each Led fixture for a minimum of 90 minutes. Connect unswitched circuit to the emergency battery packs, and switched circuit to LED drivers.

- c. Fixtures shall be securely mounted (chains or wires are not allowed) and include wire guards to protect lamps in each fixture.
 - d. Install a 3-way switch at each enclosure entrance to control the lighting.
13. Receptacles: Provide one 2P, 3W, 20-amp heavy-duty duplex ground fault current interrupter (GFCI) receptacle for each three cubicles or fraction thereof. Space receptacles equidistant along the interior wall of the aisle space. Install a separate 20-amp circuit for every three (3) receptacles.
14. All branch circuit wiring shall be installed in conduit and shall be No. 12 AWG or larger.//

SPEC WRITER NOTE: Edit the following for indoor or outdoor application.

C. Finish:

- 1. All metal surfaces shall be thoroughly cleaned, phosphatized and factory primed prior to applying baked enamel or lacquer finish.
- //2. Provide a light gray finish for indoor switchgear. //
- //3. Outdoor switchgear:
 - a. Interior finish shall be light gray.
 - b. Exterior finishes shall be as specified in the Section 09 06 00, SCHEDULE FOR FINISHES.
 - c. The underside of the switchgear and enclosure shall be treated with corrosion resistant compounds, epoxy resin, or rubberized sealing compound.//

2.3 BUS

A. Bus Bars and Interconnections:

- 1. Provide copper buses, fully rated for the amperage shown on the drawings for entire length of the switchgear.
- 2. Fully insulate and totally enclose the buses within the bus compartment of switchgear cubicles.

3. Mount the buses on appropriately spaced insulators and brace to withstand the available short circuit currents.
 4. The bus and bus compartment shall be designed so that the acceptable NEMA standard temperature rises are not exceeded.
 5. Install a copper ground bus the full length of the switchgear assembly.
 6. All bolts, nuts, and washers shall be //zinc-plated//cadmium-plated// steel. Bolts shall be torqued to the values recommended by the manufacturer.
 7. Make provisions for future bus extensions by means of bolt holes or other approved method.
- B. Insulation: The insulation shall be a high flame-retardant, self extinguishing, high track-resistant material that complies with the IEEE C37.23 65 degree C (149 degree F) temperature rise.
- C. Control Bus: Extend the control buses to all of the circuit breaker cubicles including spare and spaces for future circuit breakers.

2.4 CIRCUIT BREAKERS

- A. Breakers that have the same ratings shall be interchangeable with other breakers in that line-up.

SPEC WRITER NOTE: The type of breakers allowed will depend on the application. In general, include contractor choices when possible. Vacuum breakers are preferred.

- B. Circuit breakers shall have the following features:
1. Drawout, // SF6 // vacuum// interrupter type.
 - //a. Sulfur Hexafluoride (SF6):
 - 1) Three independently sealed SF6 interrupters.
 - 2) Protect the interrupter contacts from moisture and contaminated atmospheres.
 - 3) Arc interruption based on SF6 single-pressure puffer principle.
 - 4) Low pressure; normal operating pressure of 250 kPa (2.5 bar) gauge for the SF6.
 - 5) Provide a low-pressure alarm on each interrupter.
 - 6) Readily accessible contact wear indicator for each interrupter.
 - 7) Provisions for slow closing (testing).
 - 8) Breaker total interrupting time of 5 cycles.

- 9) Maintenance free interrupter.//
- //b. Vacuum:
- 1) Three independent sealed high-vacuum interrupters.
 - 2) Protect the interrupter contacts from moisture and contaminated atmospheres.
 - 3) Readily accessible contact wear indicator for each interrupter.
 - 4) Breaker total interrupting time of 3 cycles.
 - 5) Maintenance free interrupter.
 - 6) Contact surfaces to be of special alloys (such as copper chrome) to reduce effect of chopping.//
2. Operating mechanism:
- a. The mechanism shall operate in a quick-make, quick-break manner and shall be charged by a small universal motor to provide stored-energy for breaker operation. Breaker tripping, closing, and indicating lamps shall be DC operated.
 - b. The speed of the contacts during the operation shall be independent of the control voltage and the operator's movements.
 - c. Equip the mechanism for manual opening and closing of the contacts during loss of normal control power.
3. Relays: Comply with IEEE C37.90, integrated digital type with test blocks and plugs. Provide relay functions per the IEEE C37.2, and as shown on the drawings.
4. Drawout rails:
- a. Design the rails to guide the breakers to their disconnected, test, and connected positions. Provide a positive stop at each of the positions by a levering mechanism.
 - b. The breaker shall maintain contact with ground in all positions through flexible connections and ground shoes.
 - c. Make provisions for padlocking the breaker in the test and disconnected position.
5. Power line and load disconnecting contact fingers and springs:
- a. The contact fingers shall be silver-plated, full-floating, self-aligning, self-coupling, and designed for cleaning action during engaging and disengaging movements.
 - b. Provide adequate flexibility between stationary and movable components to assure proper meeting of the contact fingers, while also providing adequate pressure on the contact surfaces.

6. The stationary contacts for the line and load breaker contact fingers shall be isolated from the breaker compartment by shutters when the breaker is removed from the connected position.
7. The control and auxiliary contacts of the breaker shall be silver plated, multi-contact, self-coupling, plug and socket type. The contacts shall connect the circuits through terminal blocks that shall be conveniently mounted on the breaker for visual inspection.
8. Mechanical interlocks:
 - a. Shall prevent the breaker from movement, except when the breaker contacts are in the open position.
 - b. Shall prevent the breaker from closing the contacts while in the connected position, except when the power line and load disconnecting contacts are completely connected.
- C. The interrupting ratings of the breakers shall be not less than // 250 // 350 // 500 // 750 // 1000 // MVA.

SPEC WRITER NOTE: The A/E shall show the current transformer ratios on the drawings.

2.5 CURRENT TRANSFORMERS

- A. Provide encapsulated type current transformers or approved equal. The transformers shall have a mechanical and one-second thermal rating in RMS amperes of not less than the momentary and interrupting rating of the breaker at rated voltage.
- B. Provide transformer ratios as shown on the drawings. Accuracies shall be coordinated with the associated relays by the switchgear manufacturer to assure proper operation at the selected pick-up and operating current ratings.

2.6 POTENTIAL TRANSFORMERS

- A. The potential transformers shall be encapsulated, drawout, disconnecting type, and shall be properly protected by primary current-limiting fuses.
- B. When the transformers are withdrawn from the compartment the primary terminals shall be grounded.
- C. The transformer ratios and accuracies shall be coordinated, with the associated relays by the switchgear manufacturer.

2.7 CONTROL POWER TRANSFORMERS

- A. The control power transformers shall be encapsulated, drawout, disconnecting type and shall be properly protected by primary current-limiting fuses.
- B. The ratings of the transformer shall be as indicated on the drawings.
- C. Refer to the drawings for rating and capacity of the circuit breaker equipped panelboard served by the control power transformer.
- D. Equip the control power transformer compartment door with indicating lights and nameplates to indicate when the control power is energized.

SPEC WRITER NOTE: Include the following paragraph only for projects that include two incoming feeders, from electric utility company or other source.

//E. Dual Control Power Supplies:

- 1. For each of the incoming feeders, provide a separate control power transformer.
- 2. An automatic transfer switch shall transfer the secondary connected load as follows:
 - a. While the preferred incoming feeder is energized, the load shall be connected to the transformer energized by the feeder.
 - b. While the preferred incoming feeder is de-energized and the other incoming feeder is energized, the load shall be transferred to the energized incoming feeder.//

SPEC WRITER NOTE: Include the following paragraph only for projects that include utility metering.

//**2.8 ELECTRIC UTILITY COMPANY EQUIPMENT**

- A. Provide separate cubicles for electric utility company metering equipment.
- B. Provide suitable arrangements within the electric utility company primary metering cubicles for mounting metering equipment. Obtain the electric utility company's approval of the cubicle arrangements prior to fabrication of the switchgear.
- C. Allow access to electric utility company personnel as required for installation of utility metering equipment.//

2.9 BATTERY SYSTEM

- A. Batteries:
 - 1. Provide high discharge rate type maintenance-free nickel-cadmium batteries. Battery voltage shall be // 125 // 48 // volts nominal.

Calculate the battery capacity based on the lowest ambient temperature in the room where it is to be installed. Include a safety margin of 50 percent for reserve capacity.

a. Provide sufficient battery capacity to carry all continuous loads (lamps, relays, etc.) for 8 hours and then perform the greater of the following duties, with the charger de-energized.

- 1) Trip all circuit breakers simultaneously or,
- 2) Close the largest breaker in a line-up of four or less breakers, or close the two largest breakers simultaneously in a line-up of more than four breakers. Breaker closing current shall include both the spring release coil current and the starting current of the spring charging motor.

2. Provide battery connector covers for protection against external short circuits.

3. Provide corrosion-resistant steel battery racks.

//4. In seismic areas, batteries shall be secured to the battery rack to prevent overturning during a seismic event. Battery rack shall also be secured to the floor.//

B. Battery Charger:

1. Provide a charger of the full-wave rectifier type utilizing silicon controlled rectifiers as the power-control elements. Construction shall be modular with plug-in control units for easy replacement.
2. The charger shall maintain 1/2 of one percent voltage regulation from no load to full load for line voltage variation of 10 percent, and frequency variation of 3 Hz from 60 Hz.
3. The charger shall maintain a nominal float voltage of 1.4 vpc, and a nominal equalizing voltage of 1.5 vpc.
4. The charger shall be capable of continuous operation in an ambient temperature of 40 degrees C (104 degrees F) without derating. The charger shall be installed in a convection cooled NEMA Type 1 ventilated enclosure. The housing is to have a hinged front door with all equipment accessible from the front.
5. Provide both AC and DC transient protection. Charger shall be able to recharge a fully discharged battery without tripping AC protective devices. AC circuit breaker shall not trip under any DC load condition, including short circuit on output terminals.
6. The charger shall be capable of supplying the following demand simultaneously:

- a. Recharging a fully discharged battery in 12 hours.
- b. Supervisory panel and control panel.
- c. Steady loads (indicating lamps, relays, etc.).
- 7. The charger shall have fused AC input and DC output protection.
- 8. The charger shall not discharge the batteries when AC power fails.
- 9. The charger shall have the following accessories:
 - a. On-off control switch with pilot light.
 - b. AC power failure alarm light.
 - c. High DC voltage alarm light.
 - d. Low DC voltage alarm light.
 - e. Ground detection switch and alarm light.
 - f. DC ammeter - 2 percent accuracy.
 - g. DC voltmeter - 2 percent accuracy: Float/equalize voltage marked in red on voltmeter.
 - h. Provisions for activation of remote annunciation of trouble for the above conditions.

2.10 METERING

- A. Refer to Section 25 10 10, ADVANCED UTILITY METERING. Refer to drawings for meter locations.
- B. As necessary, provide vertical structure with a front hinged door to provide safe isolated access to meters and all associated terminal and fuse blocks for maintenance, calibration or testing.
- C. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- D. Provide voltage transformers including primary fuses and secondary protective devices for metering as shown on the drawings.

2.11 OTHER EQUIPMENT

- A. Furnish tools and accessories required for circuit breaker and switchgear test, inspection, maintenance, and proper operation.
- B. Cable terminations:
 - 1. Cable terminations shall conform to the requirements in Section 26 05 13, MEDIUM-VOLTAGE CABLES.
 - 2. Coordinate cable terminations with the switchgear being furnished.

SPEC WRITER NOTE: The A/E shall evaluate the need for surge arresters, particularly in areas prone to lightning and voltage surges. Select surge arresters to minimize risk of damage to external electrical and electronic equipment.

C. Medium-voltage surge arresters:

1. Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11.
2. Provide each ungrounded conductor of each incoming circuit with an appropriate arrester for the application voltage.
- //3. Provide each phase of each circuit breaker with appropriate surge arrester for application voltage.//

D. Panelboards: Requirements for panelboards shown to be installed in the switchgear shall be as shown on the drawings and in Section 26 24 16, PANELBOARDS.

E. Circuit breaker removal equipment: Furnish a //portable circuit breaker removal lift and carriage//permanent circuit breaker removal device mounted on top of enclosure// for installation and removal of circuit breakers.

2.12 CONTROL WIRING

Switchgear control wiring shall not be less than No. 14 AWG copper 600 volt rated. Install wiring complete at the factory, adequately bundled and protected. Provide separate control circuit fuses in each breaker compartment and locate for ease of access and maintenance.

2.13 NAMEPLATES AND MIMIC BUS

- A. Nameplates: For Normal Power system, provide laminated black phenolic resin with white core with 12 mm (1/2 inch) engraved lettered nameplates next to each circuit breaker. For Essential Electrical System, provide laminated red phenolic resin with white core with 12 mm (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.
- B. Mimic Bus: Provide an approved mimic bus on front of each switchgear 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.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and manufacturer's instructions.
- B. Anchor switchgear with rustproof bolts, nuts, and washers not less than 12 mm (1/2 inch) diameter, in accordance with manufacturer's instructions, and as shown on drawings.
- //B. In seismic areas, switchgear shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.//

SPEC WRITER NOTE: 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.

- C. Exterior Location. Mount switchgear on concrete slab. Unless otherwise indicated, the slab shall be at least 200 mm (8 inches) thick, reinforced with a 150 by 150 mm (6 by 6 inches) No. 6 mesh placed uniformly 100 mm (4 inches) from the top of the slab. Slab shall be placed on a 150 mm (6 inches) thick, well-compacted gravel base. The top of the concrete slab shall be approximately 100 mm (4 inches) above the finished grade. Edges above grade shall have 12.5 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 200 mm (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 75 mm (3 inches) above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Interior Location. Mount switchgear on concrete slab. Unless otherwise indicated, the slab shall be at least 100 mm (4 inches) thick. The top of the concrete slab shall be approximately 100 mm (4 inches) above finished floor. Edges above floor shall have 12.5 mm (1/2 inch) chamfer. The slab shall be of adequate size to project at least 100 mm (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. An authorized representative of the switchgear manufacturer shall technically supervise and participate during all of the field adjustments and tests. Major adjustments and field tests shall be witnessed by the //Resident Engineer// //COR//. The manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

//B. Prior to the final inspection for acceptance, a technical representative from the electric utility company shall witness the testing of the equipment to assure the proper operation of the individual components, and to confirm proper operation/coordination with electric utility company's equipment.//

C. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. In addition, include the following:

1. Visual Inspection and Tests:

- 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. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
- g. Verify appropriate equipment grounding.
- //h. Confirm correct operation and sequencing of key-type mechanical interlock systems.//
- i. Vacuum-clean enclosure interior. Clean enclosure exterior.
- j. Inspect insulators for evidence of physical damage or contaminated surfaces.
- k. Verify correct shutter installation and operation.
- l. Exercise all active components.

- m. Verify the correct operation of all sensing devices, alarms, and indicating devices.
 - n. Verify that vents are clear.
 - o. 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 switchgear to ensure correct bus phasing from each source.
 - e. Circuit breakers shall be tripped by operation of each protective device.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the medium-voltage circuit breaker switchgear is in good operating condition and properly performing the intended function.

3.4 TEMPORARY HEATING

- A. Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.5 WARNING SIGN

- A. Mount on each entrance door of the //outdoor switchgear enclosure//switchgear room//, approximately 1.5 M (5 feet) above grade or floor, a clearly lettered warning sign for warning personnel. The sign shall be attached with rustproof metal screws.

3.6 ONE LINE DIAGRAM AND SEQUENCE OF OPERATION

- A. At final inspection, an as-built one line diagram shall be laminated or mounted under acrylic glass, and installed in a frame mounted in the switchgear room or in the outdoor switchgear enclosure.
- B. Furnish a written sequence of operation for the switchgear and connected line side/load side electrical distribution equipment. The sequence of operation shall be laminated or mounted under acrylic glass, and installed in a frame mounted in the switchgear room or in the outdoor switchgear enclosure.

- C. Deliver an additional four copies of the as-built one line diagram and sequence of operation to the //Resident Engineer// //COR//.

3.7 AS-LEFT RELAY SETTINGS, AND FUSE RATINGS FOR CONTROL EQUIPMENT

- A. The relay settings shall be set in the field by an authorized representative of the switchgear manufacturer per the approved Overcurrent Protective Device Coordination Study in accordance with Section 26 05 73, OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY.
- //B. The relay settings of the main breaker(s) shall be reviewed by the electric utility company to assure coordination with the electric utility company primary fusing. Prior to switchgear activation, provide written verification of this review to the //Resident Engineer// //COR//.
- C. Post a durable copy of the "as-left" relay settings, and fuse ratings for control equipment in a convenient location in the //switchgear room //outdoor switchgear enclosure//. Deliver four additional copies of the settings and fuse ratings to the //Resident Engineer// //COR//. Furnish this information prior to the activation of the switchgear.

3.8 INSTRUCTION

- A. Furnish the services of a factory-trained technician for one 4-hour training period for instructing personnel in the maintenance and operation of the switchgear, on the dates requested by the //Resident Engineer// //COR//.

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