

SECTION 26 13 00
MEDIUM-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, connection and testing of the medium voltage switchgear. Switchgear, generators, and controls shall be provided by a single supplier who shall be solely responsible for integration of paralleling controls and communications specified herein.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 13, MEDIUM-VOLTAGE CABLES: Medium voltage cables and splices.
- 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 to ground for possible ground fault currents.
- E. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Short circuit and coordination study.
- F. Section 26 13 13, GENERATOR PARALLELING CONTROLS: For switchgear used as part of a generator paralleling system.
- G. Section 26 32 13, ENGINE-GENERATORS.
- H. Section 13 34 19, METAL BUILDING SYSTEMS.

1.3 QUALITY ASSURANCE

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

1.4 FACTORY TESTS

- A. Medium voltage switchgear shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Tests shall be conducted as per UL and ANSI Standards. Factory tests shall be certified.
- B. Thoroughly test the switchgear at the factory with the circuit breakers in the connected position in their cubicles. The factory tests shall be in accordance with IEEE C37.09 and shall include the following tests:
 - 1. Design Tests
 - 2. Production Tests

3. Conformance Tests: These tests shall also include testing as required in ANSI C37.55, C37.57 and NEMA C37.54.
- C. The following additional tests shall be performed:
1. Verify that circuit breaker sizes and types correspond to drawings and coordination study.
 2. Verify that current and voltage transformer ratios correspond to drawings or as recommended by the manufacturer as approved by the COTR.
 3. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
 4. Confirm correct operation and sequencing of electrical and mechanical interlock systems 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.
 5. Verify correct barrier and shutter installation and operation.
 6. Exercise all active components.
 7. Inspect indicating devices for correct operation.
 8. 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. The test voltage shall be applied for one minute.
 9. 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.
 10. If applicable, verify correct function of control transfer relays located in the switchgear with multiple control power sources.
 11. Perform phasing checks on double-ended or dual-source switchgear to insure correct bus phasing from each source.
- D. Furnish four (4) copies of certified manufacturer's factory test reports to the COTR prior to shipment of the switchgear to ensure that the switchgear has been successfully tested as specified.
- E. 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 COTR not less than 30 days prior to making tests at the factory.

1.5 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 1. Shop drawings shall not be submitted until the Electrical System Protective Device Study has been submitted and approved.
 2. Provide detailed drawings with sufficient information, clearly presented, to determine compliance with drawings and specifications.
 3. Prior to fabrication of switchgear, submit four copies of the following data for approval:
 - a. Complete electrical ratings
 - b. Circuit breaker sizes
 - c. Interrupting ratings
 - d. Safety features
 - e. Accessories and nameplate data
 - f. One-line diagram of the primary distribution system.
 - g. Elementary and interconnection wiring diagrams.
 - h. Technical data for each component.
 - i. Dimensioned exterior views of the switchgear.
 - j. Dimensioned section views of the switchgear.
 - k. Floor plan of the switchgear and associated enclosure.
 - l. Foundation plan for the switchgear in conformance with plans and specifications.
 - m. Provisions and required locations for external conduit and wiring entrances.
 - n. Dimensions and approximate design weights.
 - o. Concrete pad design requirements.
- C. 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. Include complete interconnection diagrams that show all components of the switchgear line-up and remote components.
 - b. Include complete diagrams of the internal wiring for each of the items of equipment.
 - c. The diagrams shall identify the terminals to facilitate in the installation, maintenance and operation.
 - d. Approvals will be based on complete submissions of manuals together with shop drawings.

2. Two weeks prior to the project final inspection or the inspection of the applicable phase that includes switchgear installation, submit four copies of a final updated maintenance and operating manual to the COTR. Update the manual to include any information necessitated by shop drawing approval.

D. Test Reports:

1. Submit four copies of certified conformance test reports for approval. Reports shall include, but not be limited to, interrupting, short time, momentary, BIL, high potential, fault close, and endurance performance.
2. Submit four copies of the certified factory design and production test reports for approval.
3. Two weeks prior to the project final inspection or phase inspection, submit four copies of the certified field test reports and data sheets to the COTR.

E. Certification: Two weeks prior to final inspection, submit four copies of the following to the COTR:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the Contractor that the materials have been properly installed, adjusted, and tested along with generator systems.

F. Certifications: Two weeks prior to the project final inspection or the inspection of the applicable phase that includes switchgear installation, submit four copies of the following certifications to the COTR:

1. Certification by the manufacturer of the switchgear that the equipment 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. American Concrete Institute (ACI):

ACI 318.....Building Code Requirements for Structural
Concrete

C. American National Standards Institute (ANSI):

C37.20.3.....IEEE Standard for Metal-enclosed Interrupter
Switchgear

C37.55.....Switchgear-Metal-Clad Switchgear Assemblies-
Conformance Test Procedures

- C37.57.....Switchgear-Metal-Enclosed Interrupter Switchgear Assemblies Conformance Testing
- C37.85.....Switchgear-Alternating-Current High-Voltage Power Vacuum Interrupters-Safety Requirements for X-Radiation Limits
- C39.1.....Electrical Analog Indicating Instruments, Requirements for
- D. Institute of Electrical and Electronics Engineers (IEEE):
 - C37.04.....Standard Rating Structure for AC High-Voltage Circuit Breakers
 - C37.09.....Standard Test Procedure for AC High-Voltage Power Circuit Breakers Rated on a Symmetrical Current Basis
 - C37.20.2.....Standard for Metal-Clad Switchgear
 - C37.90.....Standard for Relays and Relay Systems Associated with Electric Power Apparatus
 - C57.13-93 Standard Requirements for Instrument Transformers
- E. National Electrical Manufacturers Association (NEMA):
 - C37.06.1.....Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 - C37.54.....Switchgear - Indoor Alternating Current High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear Assemblies - Conformance Test Procedures
 - C37.57.....Switchgear-Metal-Enclosed Interrupter Switchgear Assemblies-Conformance Testing
 - LA 1.....Surge Arrestors
 - SG 4.....Alternating-Current High-Voltage Circuit Breakers
 - SG 5.....Power Switchgear Assemblies
- F. National Fire Protection Association (NFPA):
 - 70.....National Electrical Code (NEC)

PART 2-PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The switchgear shall be in accordance with NEMA SG-4, IEEE C37.20.2 and the National Electrical Code as minimum requirements, and shall be as shown on the drawings and as specified.
- B. Indicating instruments shall be in accordance with ANSI C39.1
- C. Relays and relay systems shall be in accordance with IEEE C37.90.
- D. Instrument transformers shall be in accordance with IEEE C57.13.

- E. The switchgear line-up shall be a complete, grounded, continuous-duty, integral assembly, metal clad, dead-front, dead-rear, self-supporting, indoor type switchgear assembly, to be installed in site-fabricated metal building as shown on the drawings and specified herein. Incorporate devices shown on the drawings and everything required to fulfill the operational and other requirements shown on the drawings.
- F. Ratings shall be not less than shown on the drawings. Short circuit ratings shall be not less than 500 MVA.
- G. Switchgear shall conform to the arrangements and details of the drawings and space designed for installation.
- H. Interlocking shall be provided as shown on the drawings and specifications and as required for the safety of personnel and safe operation of the equipment.
- I. 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.
- J. All non-current carrying parts shall be grounded per applicable articles of the National Electrical Code. Refer to Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS for additional requirements.

2.2 HOUSING

- A. The equipment and structure shall have the following features:
 - 1. Frames and enclosures:
 - a. The assembly shall be braced with reinforcing gussets and jig welds as required to assure rectangular rigidity.
 - b. The enclosure shall be steel, leveled and not less than the gauge required by NEMA and ANSI Standards.
 - 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 cadmium-plated steel.
 - 2. Cubicles:
 - a. An individual cubicle shall be supplied for each circuit breaker and each future circuit breaker indicated. Cubicles shall also be provided for auxiliaries, metering, and transitions as indicated on the drawings.
 - 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. 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) Electronic type relays.
 - 2) A breaker control switch. Local/remote control selector switch.
 - 3) Breaker-position-indicator lamps energized by the station battery.
 - 4) Relays and/or metering as indicated on the drawings or other sections of the specifications.
 - 5) Any additional items indicated on the drawings.

B. Walk-in Protected Enclosure:

1. This project shall provide a prefabricated metal building into which the switchgear will be installed. See drawings and specification Section 13 34 19 metal building systems. Switchgear manufacturer shall coordinate with building design/manufacturer to insure full functionality, constructability, accessibility and maintainability.

2.3 BUS

A. Bus Bars and Interconnections:

1. Provide copper buses, fully rated for 1200 Amps.
2. Fully insulate and totally enclose the buses within the bus compartment of the switchgear cubicle.

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 ground bus the full length of the switchgear assembly.
- B. Insulation: The insulation shall be a high flame-retardant, self extinguishing, high track-resistant material that complies with the NEMA Standard 65 degree C 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.
- B. The circuit breakers shall be in accordance with IEEE C37.04, NEMA C37.06.1 and NEMA SG-4. Breakers shall have the following features:
1. Drawout, vacuum type.
 - a. 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) Provisions for slow closing (testing).
 - 5) Breaker total interrupting time of 3 cycles.
 - 6) Maintenance free interrupter.
 - 7) Contact surfaces to be of special alloys (such as copper chrome) to reduce effect of chopping.
 - 8) Provide each phase of main bus with appropriate surge arrester for application voltage. Select surge arresters to minimize risk of damage to external electrical and electronic equipment.
 - 9) Vacuum interrupters shall meet the safety requirements of ANSI C37.85.
 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 and provide capability for slow manual operation during inspection of the contact wiping action.
3. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs. See required relay manufacturer and types on drawings.
4. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three-wire systems, with the following features:
 - a. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
 - b. Switch-selectable digital display with the following features:
 - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
 - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - 4) Three-Phase Real Power: Plus or minus 2 percent.
 - 5) Three-Phase Reactive Power: Plus or minus 2 percent.
 - 6) Power Factor: Plus or minus 2 percent.
 - 7) Frequency: Plus or minus 0.5 percent.
 - 8) Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
 - 9) Total harmonic distortion.
 - c. Communications module suitable for remote monitoring of meter quantities and functions. Interface communication and metering requirements according to Section 26 27 13, ELECTRICITY METERING.
5. 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.
6. 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.
 - c. Mount the contacts on the breaker so that they can be conveniently inspected.
7. 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.
8. 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. Provide three sets of "a" and "b" auxiliary contacts minimum.
9. 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 500 MVA.

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 recommended by the manufacturer. Accuracies shall be coordinated with the associated relays and meters by the switchgear manufacturer and genset 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 and meters by the switchgear and genset manufacturers.

2.7 BATTERY SYSTEM

A. Batteries:

1. Provide sealed lead acid. Battery voltage shall be 125 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, microprocessors, etc.) for 4 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. Each battery cell shall have electrolyte minimum and maximum level indicators, and flip top flame arrester vent cap.
3. Provide battery connector covers for protection against external short circuits.
4. Provide steel battery racks with an alkali resistant finish.
5. 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 I 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.

2.8 ENGINE GENERATOR CONTROL AND METERING

- A. Provide vertical structure with a front hinged door to provide safe isolated access to generator controls, meters, and all associated terminal and fuse blocks for maintenance, calibration or testing while the gear is energized. Refer to Specification Section 26 32 13 ENGINE-GENERATOR, Section 26 13 13 GENERATOR PARALLELING CONTROLS and drawings.
- B. Provide ring-type current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- C. Provide voltage transformers including primary fuses and secondary protective devices for metering as shown on the drawings.

2.9 OTHER EQUIPMENT

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

2.10 AUXILIARIES

- A. Install all additional components required for proper operation of the switchgear.
- B. Provide cable connected, portable, hand held, remote operating station for opening and closing of circuit breakers when selector switch in "remote" position. Provide 20 feet of cable.

2.11 CONTROL WIRES

Switchgear control wires shall not be less than No. 14 AWG copper 600 volt, Class B, Stranded SIS. Install wiring complete at the factory, adequately bundled and protected. All conductors across hinges, and all conductors for interconnection between shipping units shall be Class C stranded. Conductors shall be sized in accordance with the NEC. Provide separate control circuit fuses in each breaker compartment and locate for ease of access and maintenance.

2.12 TEST CABINET

The test cabinet shall facilitate the convenient testing of the power circuit breakers and shall be installed where indicated on the drawings.

2.13 NAMEPLATES AND MIMIC BUS

- A. Nameplates: Provide laminated red phenolic resin with white core with 1/2 inch [12mm] 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 switchgear assembly. Color shall be red, 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. Submit proposed layout with submittal.

2.14 ONE LINE DIAGRAM

- A. An as-built one-line diagram, clearly identified, shall be laminated or mounted under plexiglas, installed in a frame and mounted on a wall adjacent to the switchgear assembly.
- B. Deliver an additional four spare copies (same as at the switchgear unit) of the one line diagram to the COTR.

2.15 ACCESSORIES

Furnish all accessories to the COTR as recommended by the switchgear assembly manufacturer to facilitate the convenient maintenance and operation of the assembly.

2.16 AS-LEFT RELAY SETTING AND FUSE RATINGS

- A. Coordinate relay settings of the medium voltage switchgear breakers in accordance with Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
- B. The settings of the main breaker(s) shall be reviewed by the power company to assure coordination with the utility primary fusing. Prior to switchgear activation, provide verification of this review to the COTR.
- C. The settings shall be calibrated and set in the field by an authorized representative of the switchgear and generator manufacturers.
- D. Post a durable copy of the "as-left" relay settings and fuse ratings in a convenient location within the switchgear assembly. Deliver four additional copies of the settings and fuse ratings to the COTR. Furnish this information prior to the activation of the switchgear.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the switchgear in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.
- B. Anchor switchgear to the concrete slab with plated 1/2 inch [12.5mm] minimum anchor bolts, or as recommended by the manufacturer. Provide concrete slab design in accordance with design parameters provided herein. 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 3 inches [75mm] 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 and generator manufacturers shall technically supervise and participate during all of the field adjustments and tests. Major adjustments and field tests shall be witnessed by the COTR. The manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturers' recommendations.

B. Perform manufacturers' required field tests in accordance with the manufacturers' recommendations. Within 30 days of completion Contractor to do a thermographic survey of all new connections, correct deficiencies and report to COTR. In addition, 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. Verify appropriate equipment grounding.
- h. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
- i. Clean switchgear.
- 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.

3.3 FOLLOW-UP VERIFICATION

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

3.4 TEMPORARY HEATING

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 INSTRUCTION

- A. A complete set of operating instructions for the switchgear shall be laminated or mounted under acrylic glass and installed in a frame on the wall of switchgear assembly.
- B. Furnish the services of a factory-trained engineer for two, 4-hour training periods for instructing personnel in the maintenance and operation of the equipment, on the dates requested by the COTR.

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