

MEDIUM VOLTAGE METAL CLAD SWITCHGEAR

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, connection and testing of the medium voltage switchgear.

1.2 SWITCHGEAR FEATURES AND RATINGS

The design standard for the equipment specified herein is VESTA switchgear as manufactured by Industrial Electric Mfg, Fremont, California. Other equipment meeting all requirements specified may be acceptable.

1.2.1 The switchgear shall have the following features and ratings

Physical Size: each section: 24” wide x 60” Deep x 96” high

Fully Front Accessible, Metal clad switchgear

Ratings: 5 kV – 15 kV, 95 kV BIL, 600A – 1200A, 31.5 kA

Arc Ratings: 15 kV, 25 kA, type 2A

Draw out Breaker, CPT and PT

IR windows and Viewing windows in front and back

Breaker: UL listed Magnetically Actuated ABB VM1 or equivalent

The equipment supplied shall be the tested and UL and cUL / CSA listed product of a manufacturer of electrical power equipment with a minimum of five years experience in the production of the type of equipment herein specified.

1.3 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, ANSI and CSA Standards.
- 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

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide detailed drawings with sufficient information, clearly presented, to determine compliance with drawings and specifications.
2. 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. Elementary and interconnection wiring diagrams
 - e. Single line and three line diagrams
 - f. Dimensioned exterior views of the switchgear.
 - g. Floor plan of the switchgear.
 - h. Foundation plan for the switchgear.

1.5 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 National Standards Institute (ANSI):

- C37.20.3.....IEEE Standard for Metal-enclosed Interrupter Switchgear
- C37.20.4.....IEEE Standard for Indoor AC Switches (1kV-38kV) for
Use in Metal-enclosed Switchgear
- C37.22.....American National Standard Preferred Ratings and Related
Required Capabilities for Indoor AC Medium-Voltage
Switches Used in Metal-Enclosed Switchgear
- C37.47.....Medium voltage Current-Limiting Type Distribution Class
Fuses and Fuse Disconnecting Switches

- 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
- C. Canadian Standards Association
- CSA C22.2 No. 31-04 Switchgear Assemblies
- 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
 - C37.48.....Guide for Application, Operation and Maintenance of
Medium voltage Fuses, Distribution Enclosed Single Pole
Air Switches, Fuse Disconnection Switches and
Accessories
 - 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):
- C37.06.1Guide 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 4Alternating-Current High-Voltage Circuit Breakers

SG 5Power Switchgear Assemblies

PART 2-PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. The switchgear shall be in accordance with NEMA SG-4, IEEE C37.20.2, applicable UL and CSA standards and listings 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, metal clad, dead-front, dead-rear, self-supporting, front connected switchgear assembly. 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 270 MVA for 5 kV systems and 800 MVA for 15 kV systems, but the ratings on the drawings shall apply if higher.
- 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 as required for the safety of personnel and safe operation of the equipment.

2.2 SEISMIC REQUIREMENTS

The switchgear shall meet the following seismic standards. The equipment shall be tested

on a shake table to comply with these standards.

- a. International Building Code, IBC-2006 Sections 1613 and 1708
ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures
- b. International Code Council, ICC-ES-AC156 Acceptance Criteria for Seismic Qualification by Shake Table Testing of Nonstructural Components and Systems
- c. IEEE-344-2004, Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Station
- d. IEEE-693-2005, Recommended Practices for Seismic Design of Substations
- e. Telcordia GR-63, Recommended Practices for Seismic Design of Telecommunications Equipment.

2.3 HOUSING

- A. The equipment and structure shall have the following features:
 1. Frames and enclosures:
 - a. The assembly shall be braced with reinforcing gussets as required to assure rectangular rigidity.
 - b. The enclosure shall be steel with all exposed parts painted and fabricated from not less than the gauge required by NEMA and ANSI Standards.
 - c. Provide adequately spaced holes for connecting adjacent structures to insure proper alignment and to allow for future additions.
 - d. The equipment sections shall be configured to provide an arc resistance enclosure with the ability to have all cable terminations located near the front of the equipment with suitable clearances and bending radius for the cable type and terminations types specified. The cable compartment and CTs shall be front accessible.
 - e. Provide doors, covers, and infrared windows as shown to allow for UL and cUL / CSA listed rating as arc resistance equipment as supplied. Provide an extension from the arc plenum to allow for connection to ducting (by others) for the exit of gases resulting from an internal arc.
 - f. Properly isolate circuit breakers, buses, and cable terminations in separate compartments with steel partitions or barriers of approved and tested materials. Meet all UL, ANSI, CSA and NEMA standards regarding individual section isolation for bus compartments.

2. Switchgear Sections:
 - a. The individual switchgear sections shall be comprised of three individual compartments: a lower cable or PT compartment; a middle circuit breaker, PT or CPT compartment; and an upper LV control compartment.
 - b. A circuit breaker or CPT compartment shall be supplied for each circuit breaker, CPT or future circuit breaker indicated.
 - c. Each compartment furnished with a circuit breaker (active or spare) shall be fully equipped as noted on drawings and specified below.
 - d. Each compartment 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 for any the relays and meters in the associated LV control compartment.
3. Compartment 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 equipped with infrared windows or tested blast proof Lexan windows as shown on the drawings.
 - b. Each door shall include suitable handles. Suitable heavy duty hinges for the arc resistant rating shall be provided to attach the doors.
 - c. The following equipment shall be mounted on the door of the low voltage compartment:
 - 1) Draw out or other protective relays as specified herein or shown on the drawings.
 - 2) A breaker control switch.
 - 3) Relays and/or metering as indicated on the drawings or other sections of the specifications.
 - 4) Any additional items indicated on the drawings for example, transfer switch controller, Generator controller, HMI, etc.

C. Finish:

1. All metal surfaces shall be thoroughly cleaned, phosphatized and finished using a power coat system tested to at least 3000 hours for salt spray resistance.
2. Provide a light gray or other suitable standard factory finish for the switchgear.
3. The cutouts in the low voltage compartment shall be fully painted after punching the low voltage compartment door.

2.4 BUS

A. Bus Bars and Interconnections:

1. Provide silver plated copper buses, fully rated and tested for the amperage shown on the drawings.
2. Fully insulate and totally enclose the buses within the bus compartment of the switchgear.
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 and tested so that the acceptable NEMA, ANSI, UL and CSA 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 15 kV rated, high flame-retardant, self extinguishing, high track resistant epoxy material that complies with the NEMA Standard 65 degree C temperature rise.

2.5 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. Draw out, vacuum interrupter type, UL and cUL / CSA listed.
 - a. Vacuum:

- 1) Three independent sealed high vacuum interrupters contained within epoxy encapsulated poles for high reliability.
 - 2) Breaker total interrupting time of 3 cycles.
 - 3) Suitable contacts to allow for a minimum of 50,000 no load or light load operations without intermediate maintenance.
 - 4) Contact surfaces to be made of special chrome-copper alloys or equivalent to reduce effect of chopping.
 - 5) 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 operated by a linear magnetic operator. Breaker tripping, closing, and indicating lamps shall be AC or 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 of the contacts during loss of normal control power.
3. Relays: Comply with IEEE C37.90, integrated digital type; with test blocks and plugs.
4. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-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:
 - Phase Currents, Each Phase: Plus or minus 1 percent.
 - Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - Three-Phase Real Power: Plus or minus 2 percent.
 - Three-Phase Reactive Power: Plus or minus 2 percent.
 - Power Factor: Plus or minus 2 percent.

5. Draw-out rails:
 - a. Design the rails to guide the breakers to their disconnected, and connected positions. Provide an indication in the cubicle of each of the positions.
 - b. The breaker shall maintain contact with ground in all positions through a ground connection that has been fully tested and approved by UL.
 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 smooth 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 metal shutters when the breaker is removed from the connected position.
 8. The control and auxiliary contacts of the breaker shall be multi-contact plug on an umbilical cord with a positive locking mechanism to insure connection. The mechanism on the umbilical cord shall also provide leverage to allow for easy disconnection when the breaker is in the withdrawn position. Interlocks to prevent disconnection of the umbilical cord when the breaker is in the connected position shall be provided.
 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 270 MVA for 5kV systems and 800 MVA for 15 kV systems, but higher ratings if shown on the drawings shall apply.

2.6 CURRENT TRANSFORMERS

- A. Provide ring 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 and meters by the switchgear manufacturer to assure proper operation at the selected pick up and operating current ratings.
- C. Current transformers shall be mounted over the circuit breaker connections to the main (line) bus or load bus and shall be able to be replaced from the front of the equipment without major disassembly of the circuit breaker cubicle.

2.7 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 manufacturer.
- D. All potential transformers shall be UL and cUL / CSA listed for use in the equipment.

2.8 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.

2.9 METERING

- A. Provide ring-type current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- B. Provide voltage transformers including primary fuses and secondary protective devices for metering as shown on the drawings.

2.10 OTHER EQUIPMENT

A. Cable Terminations:

1. Cable terminations shall conform to the requirements in Section 16 05 13, MEDIUM-VOLTAGE CABLES.
2. Coordinate cable terminations with the switchgear being furnished.

B. Medium Voltage Surge Arresters:

1. Distribution class, metal-oxide-varistor type. Comply with NEMA LA 1.
2. Provide each ungrounded conductor of each incoming circuit with an arrester.

2.11 AUXILIARIES

Install all additional components required for proper operation of the switchgear.

2.12 CONTROL WIRES

Switchgear control wires shall not be less than No. 14 AWG copper 600 volt, 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 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.

2.13 NAMEPLATES

- A. Nameplates: Provide laminated black phenolic resin nameplates with white core with 1/2 inch [12mm] high engraved letters identifying each circuit breaker.
- B. Nameplates shall indicate equipment served, spaces, or spares in accordance with one line diagram shown on drawings.
- C. Nameplates shall be mounted with industrial grade adhesive or suitable plated screws such that arc rating is not impacted.

3.1 ACCEPTANCE CHECKS AND TESTS

- A. Perform manufacturer's required field tests in accordance with the manufacturer's recommendations. 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.

3.2 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.

3.3 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.