

STANDARD SPECIFICATIONS FOR MANUAL METAL-ENCLOSED SWITCHGEAR

A. General

1. Product

The metal-enclosed switchgear shall be in accordance with the applicable plans, drawings and one-line diagrams and shall conform to these specifications.

2. Assembly

The metal-enclosed switchgear assembly shall consist of one or more indoor, outdoor self-supporting bays, containing interrupter switches and/or power fuses with the necessary accessory components, all completely factory assembled and operationally checked.

3. Ratings

a) Ratings for the integrated switchgear assembly shall be as designated below. Select appropriate column.

System Voltage Class								
	5kV		15kV		25kV	25kV	35kV	35kV
kV, Nominal	4.16		14.4		24.9	24.9	34.5	34.5
kV, Maximum Design	5.5		17.5		27	27	38	38
kV, BIL	60		95		125	125	150	200
Main Bus Continuous Amp	600	1200	600	1200	600	1200	600	1200
Switch Load Interrupting	600	1200	600	1200	600	1200	600	—
Short-Circuit Ratings ①								
Amps, RMS Symmetrical	25,000	38,000	25,000	38,000	25,000	25,000	25,000	38,000*
MVA 3-Phase Symmetrical at Rated Nominal Voltage	180	275	625	950	1,000	1,000	1,500	1,500
Fault-Closing Amps, RMS Asym 3-Times Duty-Cycle ②	40,000	40,000	40,000	40,000	40,000	40,000	40,000	—
Fault-Closing Amps, RMS Asym 1-Time Duty-Cycle ③	—	61,000	—	61,000	—	—	—	—

- ① These are nominal switch ratings. Integrated switchgear unit may be limited by fuse ratings. Use the fuse ratings charts in this publication to adjust short circuit ratings, when applicable.
- ② The three-time duty-cycle fault-closing rating means that the switch can be closed 3 times into rated fault amperes and remain operable and able to carry and interrupt its rated load current.
- ③ The one-time duty-cycle fault-closing rating means that the switch can be closed 1 time into rated fault amperes and remain operable and able to carry and interrupt its rated load current.
- * The asymmetrical rating is 61,000 amperes, one-second.

b) For cubicles or bays in which overcurrent circuit protection is required on circuits, where the continuous load amperes exceed the maximum continuous ampere rating of a single fuse, a drawout circuit breaker should be specified in preference to employing paralleled expulsion fuses whose arcing products and pressures may be substantial during the interruption of fault current.

4. Certification of Ratings

a) The integrated metal-enclosed switchgear assembly shall be designed and built by the manufacturer of the basic interrupter switch who shall be completely

and solely responsible for the performance of these basic components as well as the complete integrated assembly as rated.

b) The manufacturer shall furnish upon request certification of ratings for the basic switch and fuse components and/or the integrated metal-enclosed switchgear assembly consisting of the switch and fuse components in combination with the enclosure(s).

5. Compliance with Standards and Codes

- a) ANSI C37.20.3 and IEEE Standard 27 (Standards for Switchgear Assemblies including Metal-Enclosed Bus).
- b) Applicable safety and health standards promulgated pursuant to Federal Occupational Safety and Health Act of 1970.
- c) Article 490.21(E) "Load Interrupter" in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
- d) (Optional) The switchgear assembly shall be UL listed. (Available on 5kV and 15kV switchgear only.)

B. Construction — Assembly:

1. Insulators

The interrupter-switch and fuse-mounting insulators shall be a cycloaliphatic epoxy resin system with material characteristics and restrictions as follows:

- a) Operating experience of at least twenty (20) years under similar conditions.
- b) Ablative action to ensure non-tracking properties.
- c) Adequate leakage distance established by test per IEC Standard 60507.
- d) Adequate strength for short-circuit stress established by test.
- e) Conformance with applicable ANSI and IEEE standards.
- f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the metal-enclosed gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2. High-Voltage Bus

a) Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.

- b) Bolted aluminum-to-aluminum connections (copper is optional) shall be made with a suitable number of non-corrosive bolts and nuts, and with two Belleville spring washers per bolt, one under the bolt head and one under the nut or with a wide, flange-head carriage bolt and one Belleville spring washer per bolt. As an alternate, bolted aluminum-to-aluminum connections shall be made with a suitable equivalent surface area, i.e. 1-bolt and spring washer. Bolts shall be tightened to proper torque for the particular Belleville washer.

3. Ground Bus

- a) A ground bus of short-circuit rating equal to that of the integrated assembly (or a ground connection, in the case of single-bay switchgear) shall be provided, maintaining electrical continuity throughout the integrated assembly.
- b) The ground bus shall consist of aluminum bar of 56% IACS conductivity.
- c) In each bay, the ground bus (or connector) shall be bolted to a stainless steel bracket, which shall be welded to the enclosure (copper is optional).

C. Construction - Enclosure & Finish

1. Enclosure

- a) The enclosure of each bay shall be constructed of heavy-gauge formed steel panels that maximize strength, minimize weight, and inhibit internal corrosion. (Optional all welded construction is also available.) For Category A only: externally removable bolted panels will not be accepted unless specified and when specified must be installed with tamper-resistant hardware.
- b) The basic material for the enclosure, roof and doors shall be 11-gauge, hot-rolled, pickled-and-oiled steel sheet.
- c) Each bay containing high-voltage components shall be a complete unit in itself, with full side sheets resulting in double-wall construction between bays. To guard against unauthorized or inadvertent entry, side and rear sheets shall not be externally attached with removable bolts except where tamper-resistant hardware is specified.
- d) Sufficient space shall be allowed for ease of cable pulling and installation. Space shall be free from fixed structural members or electrical devices.
- e) On multi-bay units when "thru-bushings" between the cubicles are specified, the thru-bushings should be shipped completely assembled to the cubicle and shall not require field assembly of semi-conducting grommets.

2. Doors

- a) Doors shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.
- b) Door edge flanges shall overlap with door opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects.
- c) Doors shall have an appropriate number of hinges based on door height and, in no case, less than three when door height exceeds forty (40) inches. The hinges and hinge

pins shall be stainless steel and secured in place to guard against tampering.

- d) In consideration of controlled access and tamper resistance, each door shall be equipped with a positive-action three-point latching system.
- e) Doors providing access to fuses shall have provisions to store spare fuse units or refill units.
- f) Each door is provided with a door holder to hold the door open against inadvertent closing. It shall be integral with the door and frame and shall self-secure when the door is fully opened.

For units specified with optional Category A features:

- g) Each door shall be provided with a recessed stainless-steel door handle. The door handles shall be padlockable and shall incorporate a hood to protect the padlock shackle from tampering. Each handle shall be provided with a recessed (select the hex or penta-head) bolt for additional security.

3. Access Control

- a) Doors providing access to interrupter switches with power fuses shall be mechanically or key interlocked to guard against:
 - 1) Opening the door if the interrupter switch on the source side of the power fuse is closed, and
 - 2) Closing the interrupter switch if the door is open.
- b) Doors providing access to interrupter switches only shall have provisions for padlocking.
- c) Each bay or compartment thereof containing high-voltage components shall be provided with a protective screen or second door, bolted closed, to guard against inadvertent entry to bays containing these components when the enclosure door is open.
- d) Access to the enclosure shall be from the front only, unless otherwise specified (for example) for cable termination at rear.

4. Vents

Ventilation openings shall be provided at the top and bottom of the unit as required for proper air circulation. Vents shall have stainless steel screened interior baffles to prevent entrance of foreign objects.

5. Lifting Eyes

Lifting provisions shall be removable and shall not permit entry into the interior when removed.

6. Finish

- a) Full coverage at joints and blind areas shall be achieved by processing enclosure panels or welded enclosures independently of components such as doors and roofs before assembly into the unitized structures.
- b) All surfaces shall undergo a chemical cleaning, phosphatizing or zirconization and sealing before any protective coatings are applied in order to remove oils and dirt, form a chemically and anodically neutral conversion coating, improve the finish-to-metal bond, and retard underfilm propagation of corrosion.
- c) The finishing system shall be applied without sags or runs for a pleasing appearance.

- d) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be carefully touched up to restore the protective integrity of the finish.
- e) Unless otherwise specified, the color shall be ANSI 61 Light Gray.
- f) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide if requested certification that representative test panels, protected by the manufacturer's finish system, have passed the following tests:
- 1) **Salt spray** (relates to coastal environments and/or presence of snow-melting salts or fertilizers). Scribe to bare metal and test for 2000 hours in a 5% salt spray per ASTM B-117. Loss of adhesion from bare metal should not extend more than 1/8" from the scribe. Underfilm corrosion should not extend more than 1/16" from the scribe.
 - 2) **Crosshatch adhesion** (relates to adhesion after scratching of the finish). Scribe to bare metal a crosshatch pattern of 100 1/16" wide squares. Apply Scotch 710 tape and rapidly remove. There should be 100% adhesion to the bare metal and between layers.
 - 3) **Humidity** (relates to environments with high humidity). Test for 1000 hours subject to 100% humidity at 45-50°C per ASTM 2247. There should be no blisters.
 - 4) **Impact** (relates to transit and handling damage and abuse by public). Impact the test panel with a 160 in.-lb., falling dart per ASTM D-2794. There should be no cracking or chipping of the paint on the impact side of the test panel.
 - 5) **Oil Resistance** (relates to probable contact with mineral oil). Immerse two test panels in mineral oil for 3 days, one at room temperature and one at 100°C (212°F). There should be no apparent changes, such as color shift, blisters, loss of hardness or streaking.
 - 6) **Ultraviolet Accelerated Weathering Test** (Relates to exposure to sunlight and rainfall, loss of gloss, color fading, and chalking). Continuous exposure to ultraviolet light for 500 hours per ASTM G-53 with a cycle of 4 hours ultraviolet followed by 4 hours of condensation. Loss of gloss should not exceed 50% of original gloss per ASTM D-523.
 - 7) **Water Resistance** (relates to rainfall or dew). Immerse a test panel in distilled water for 3 days at room temperature. There should be no apparent changes, such as blistering, color shift, loss of hardness or streaking.
 - 8) **Adhesion** — Fed Spec. 141A, Method 6301.1 (relates to adhesion after scratching the finish). Immerse test panel in distilled water for 24 hours. Make two parallel scratches 1" apart. Apply Scotch 710 tape and rapidly remove. There should be 100% adhesion to the bare metal and between layers.

- 9) **Abrasion Test** — Taber Abrader (relates to wear encountered during installation). Prepare a panel coated with the component of the finish intended to provide abrasion resistance. Test using a CS-10 wheel, 1000 gram weight, 3000 cycles, per Fed. Spec. 141, Method 6192. This provides a comparative test between samples.

- g) To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of nonferrous materials, galvanized, or zinc chromate plated ferrous materials. Cadmium plated ferrous parts shall not be used.

D. Basic Components:

1. Interrupter Switches

- a) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the integrated switchgear assembly. These ratings define the ability to close the interrupter switch either alone (un-fused) or in combination with the appropriate fuses three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum design voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.
- b) Interrupter switches shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame.
- c) Interrupter switches shall be provided with contact blades and interrupters for circuit closing, including fault-closing, continuous current carrying, and circuit interrupting. Interrupter switches with auxiliary blades shall not be permitted.
- d) Interrupter switches shall be positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence.
- e) Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of correct switch position.
- f) Each interrupter switch shall be provided with a switch operating handle. The handle shall be non-removable, and provisions shall be provided for padlocking in open or closed position.
- g) Interrupter switches shall utilize a quick-make, quick-break mechanism installed by the switch manufacturer. The quick-make, quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the speed of the switch operating handle.

2. Fuses

- a) Fuses shall be solid-material power fuses or current-limiting fuses as specified by the equipment purchaser.

- b) Each bay containing fuses shall be equipped with grounding provisions on the load side of the fuses and on the ground bus.

3. Metering

- a) Primary-metering compartment shall be provided as required.
- b) Access to metering compartment shall be provided with a protective screen or second door, bolted closed to guard against inadvertent contact with energized parts when the main enclosure door is open.
- c) Metering transformers shall be mounted such that established electrical clearances are maintained.
- d) All low-voltage wiring shall be located as required to minimize exposure to high voltage.

E. Labeling

1. Hazard-Alerting Signs & Labels

- a) All external doors and hinged bolted panels providing access to high voltage shall be provided with suitable hazard-alerting signs.
- b) All internal screens or doors providing access to high voltage shall be provided with "Danger" signs.
- c) All internal screens or doors providing access to interrupter switches shall be provided with danger signs indicating "Switch Blades May Be Energized in Any Position".
- d) All internal screens or doors providing access to fuses shall be provided with danger signs indicating "Fuses May Be Energized in Any Position".

2. Nameplate, Ratings Labels, & Connection Diagrams

- a) The outside of a single or multi-compartment switchgear assembly shall be provided with a nameplate indicating the manufacturer's name, catalog number, date of manufacture, and serial number.
- b) The inside of each door shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes rms symmetrical and Mva three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing and short-time (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).
- c) A one-line connection diagram showing interrupter switches, fuses, bus, and auxiliary equipment shall be provided as a drawing with each switchgear assembly.

F. Accessories

1. Fuse units or refill units, and voltage-transformer fuses for original installation and for spares shall be furnished as specified by the equipment purchaser.
2. A fuse handling tool as recommended by the fuse manufacturer shall be furnished as specified by the equipment purchaser.

G. Routine Production Tests

Production tests are those tests made to check the quality and uniformity of the workmanship and materials used in the manufacture of the switchgear. The unit shall meet the production tests described below, 1 through 3 inclusive.

1. Circuit Resistance Test

The purpose of this test is to verify that all load-interrupter switch contacts have been properly aligned and current transfer points have been properly assembled.

The DC resistance of the current carrying circuit of each switch phase from terminal to terminal of each pole in the closed position shall be measured with current of at least 10 amperes flowing. The resistance shall not exceed a limit specified by the manufacturer.

2. Dielectric Tests

Insulation withstand tests are made of the completely assembled unit to determine the ability of the insulating materials and spacing to withstand overvoltages for a specified time without flashover or puncture.

3. Operating Assurance Tests

Each switch shall be operated mechanically and tested to verify:

- a) That the switch position indicators and contacts are in correct position for both open and closed positions.
- b) That the unit circuit configuration is shown correctly.

H. Outdoor Units

In addition to the above requirements, outdoor units shall be provided with space heaters in each bay. The space heaters shall be enclosed within a perforated guard. Heater shall be fused and wired to a terminal block.

The edges of the top and sides of adjacent bays shall be covered to prevent water entry. Roof and bay interface shall be covered between each bay to prevent water entry.

For multi-bay units the roof construction shall be made with a roof cap channel where the cubicles are joined as shown in the drawing entitled Outdoor Roof Construction. (See Figure 8.)

Louvers on outdoor units shall include backup plates with stainless steel screens.

Rated Max. Voltage, kV	Rated Withstand Impulse Voltage, kV	Production Test, kV, RMS 60 Hz
5.5	60	19
17	95	34
27	125	40
38	150	80
38	200	80