

STANDARD SPECIFICATION FOR LIVE-FRONT 15KV & 25KV PSI/II, AND 35KV PSI PAD-MOUNTED SWITCHGEAR

A. General

1. Product

The 15kV or 25kV pad-mounted switchgear shall be PSI/II design (35kV shall be PSI design) as manufactured by Federal Pacific and shall conform to the following specification.

2. Assembly

The pad-mounted switchgear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, including sensing, controls, and control power supply, all completely factory-assembled and operationally checked.

3. Ratings

- a) Ratings for the integrated pad-mounted switchgear assembly shall be as designated below: (Select 15kV, 25kV, or 35kV sets of ratings from the tables below.)

| System Voltage Class | | | | |
|---|----------|--------|--------|--------|
| | 15kV† | 25kV† | 35kV‡ | |
| kV, Nominal | 14.4 | 25 | 34.4 | |
| kV, Maximum Design | 17.5 | 27§ | 38 | |
| kV, BIL | 95 | 125 | 150 | |
| Main Bus Continuous, Amps | 600 | 600 | 600 | |
| Switch Load-Interrupting, Amps | 600 | 600 | 600 | |
| Switch Fuse Load-Interrupting, Amps | 200 | 200 | N/A ¶ | |
| Switch Short-Circuit Ratings ① ② ③ ④ | | | | |
| Amps, RMS Symmetrical | Standard | 14,000 | 12,500 | 25,000 |
| | HFC | 25,000 | 25,000 | |
| Peak Withstand Current, Amperes | Standard | 36,400 | 32,500 | 65,000 |
| | HFC | 65,000 | 65,000 | |
| MVA, 3-Phase Symmetrical at Rated Nominal Voltage | Standard | 350 | 540 | 1490 |
| | HFC | 620 | 1,080 | |
| Fault-Closing Amps, RMS, Sym, 3-Time Duty-Cycle⑤ | Standard | 14,000 | 12,500 | 25,000 |
| | HFC | 25,000 | 25,000 | |

- ① These are nominal switch ratings. The integrated pad-mounted unit may be limited by fuse ratings. Use the fuse rating chart on the next page to select proper short circuit ratings.
 ② Select one set of the short-circuit ratings shown (Standard or High Fault Current - HFC) for 15kV or 25kV class applications.
 ③ Peak Current is 2.6 x Symmetrical Current.
 ④ Asymmetrical Current is 1.6 x Symmetrical Current.
 ⑤ The three-time duty-cycle fault-closing rating means that the switch can be closed three times into rated symmetrical fault amperes and remain operable and able to carry and interrupt its rated load current.
 Note: These are symmetrical current test value per the standard. The use of asymmetrical or peak current values will provide seemingly higher ratings.
 ⑥ Loadbreak fuse interrupters are not available for 35kV applications.

- § Maximum design application of the 27kV switch is 29kV.
 † For UL® Listed units, ratings are 15.5kV, 14,000 or 25,000 amperes rms symmetrical, 350 MVA, 22,400 or 40,000 amperes fault closing; and 27kV, 25,000 amperes rms symmetrical, 1080 MVA, 40,000 amperes asymmetrical fault closing.
 ‡ UL® Listed units are not available for 35kV applications.

- b) The momentary and three-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses with integral load-interrupters shall equal or exceed the short-circuit ratings of the pad-mounted switchgear.

| Fuse Ratings | | | | | | |
|----------------------------------|-----------|---------------------|---------------|---------------------------|------------|-------------------|
| Fuse Manufacturer | Fuse Type | Three-Phase MVA Sym | Amps RMS Asym | 3-Time Fault-Close Asym ① | Cont. Amps | Load-Break Amps ① |
| 14.4 kV Nominal Voltage | | | | | | |
| S&C ③ | SM-4 | 310 | 20000 | 20000 | 200 | 200 |
| S&C | SMU-20 | 350 | 22400 | 22400 | 200 | 200 |
| S&C ② | SM-5‡ | - | - | - | - | - |
| Eaton | DBU | 350 | 22400 | 22400 | 200 | 200 |
| Cooper ③ | CMU | 350 | 22400 | 22400 | 200 | 200 |
| Cooper (M-E) | NX | 620 | 40000 | 40000 | 100* | 100 |
| Cooper (CT) | X-Limiter | 620 | 40000 | 40000 | 140 | 140 |
| 25 kV Nominal Voltage | | | | | | |
| S&C ③ | SM-4‡ | 540 | 20000 | 20000 | 200 | 200 |
| S&C | SMU-20 | 540 | 20000 | 20000 | 200 | 200 |
| S&C ② | SM-5‡ | - | - | - | - | - |
| Eaton | DBU | 500 | 20000 | 20000 | 200 | 200 |
| Cooper ③ | CMU | 500 | 20000 | 20000 | 200 | 200 |
| Cooper (M-E) | NX | 1080 | 40000 | 40000 | 40 | 40 |
| Cooper (CT) | X-Limiter | 1080 | 40000 | 40000 | 40 | 40 |
| 34.5 kV Nominal Voltage ④ | | | | | | |
| S&C | SMU-20 | 500 | 13520 | 13520 | 200 | N/A |
| S&C ② | SM-5‡ | - | - | - | - | - |
| Eaton | DBU | 500 | 12500 | 12500 | 200 | N/A |

- ① When assembled with appropriate end fittings.
 ② Models with this fuse type are not UL® Listed.
 ③ Check with factory for UL® Listing status.
 ④ UL® Listed units are not available for 35kV applications.
 * 100 amp @ 13.5 kV max or 80 amp @ 15 kV.
 † Applicable to solidly-grounded-neutral systems only with fuses connected by a single conductor concentric neutral type cable to a transformer or transformers. Rating is 9,400 amperes RMS symmetrical, 15,000 amperes RMS asymmetrical (405 MVA symmetrical) for all other applications.
 ‡ Please contact factory for SM-5 applications.

4. Certification of Ratings:

The manufacturer shall be completely and solely responsible for the performance of the basic switch and load-interruption components as well as the complete integrated assembly as rated. The manufacturer shall furnish, upon request, certification of ratings of the basic switch components and/or the integrated pad-mounted switchgear assembly consisting of the switch and fuse components in combination with the enclosure.

5. Compliance with Standards and Codes

The pad-mounted switchgear shall conform to or exceed the applicable requirements of the following standards and codes:

- a) All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.
 b) Article 490.21(E) "Load Interrupters" 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.
 c) All portions of IEEE C37.74 covering design and testing of the distribution switchgear, components and ways.
 d) All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

The following optional feature may be specified:

- e) The pad-mounted switchgear shall be UL® Listed (available for 15kV and 25kV applications only).

6. Enclosure Design

- a) To ensure a completely coordinated design, the pad-mounted switchgear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.
- b) In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, ventilation and corrosion resistance.

B. Construction - Assembly

1. Insulators

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

- a) Operating experience of at least 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 pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.
- g) Each insulator shall be x-rayed to assure it is void free. An alternate testing method may be used only by approval of the engineer.

2. High-Voltage Bus

- a) Bus and interconnections shall consist of bare aluminum bar with an oxide-inhibiting agent at all bus joints.
- b) Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.
- c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of 1/2" - 13 bolts 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 under the nut 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 an appropriate foot-pounds torque.
- d) Before installation of the bus, all electrical contact surfaces shall first be prepared by abrading to remove any aluminum-oxide film.

Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

- e) Silver-flashed copper bus is optionally available for 600A applications.
 - f) 1200A bus shall be 1/2" x 2" silver-flashed copper.
- ### 3. Ground-Connection Pads
- a) A ground-connection pad shall be provided in each compartment of the pad-mounted gear.
 - b) The ground-connection pad shall be constructed of 1/4" thick stainless steel, which shall be welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

C. Construction - Enclosure and Finish

1. Enclosure

- a) The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.
- b) The basic material for the enclosure, roof and doors shall be 11-gauge hot-rolled, pickled-and-oiled steel sheet.
- c) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. Bolted structural joints are not permitted.
- d) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.
- e) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
- f) The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.
- g) Three resilient material cushions shall be placed on door-opening edges to prevent metal-to-metal contact that would damage finish and lead to premature corrosion.
- h) Enclosure top side edges shall overlap with roof side edges and form an internal maze to create an interface which shall allow ventilation of high-voltage compartments to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.
- i) A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.
- j) Insulating interphase and end barriers of NEMA GPO-3 grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings.
- k) Full-length steel barriers shall separate side-by-side compartments and barriers of the same material shall separate the front compartments from the rear compartments.
- l) Lifting tabs shall be removable and sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be an open mesh to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

- m) A closed-cell gasketing material shall be placed on the bottom flange as a protective interface between the steel enclosure and the mounting pad.
 - n) Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them (but only for a temporary time interval not to exceed one week) into the open gap when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).
 - o) Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them (but only for a temporary time interval not to exceed one week) into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).
 - p) To prevent moisture ingress, the roof shall be one-piece construction and shall not include any gasketed joints or any unground weld butt joints exposed to the exterior.
2. Doors
- a) Doors shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.
 - b) Doors providing access to high voltage shall have door-edge flanges that shall overlap with door-opening flanges and shall be formed to create an interface that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.
 - c) Doors providing access to high voltage shall have a minimum of three hinges. Door hinges shall be of stainless steel with stainless steel hinge pins to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.
 - d) In consideration of controlled access and tamper resistance, each set of double doors providing access to high voltage shall be equipped with an automatic three-point latching mechanism.
 - 1) The latching mechanism shall be spring loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.
 - 2) A penta-head socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.
 - 3) The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches.
 - i) It shall not be possible to access the penta-head actuator until the padlock is removed.
 - ii) It shall not be possible to unlatch the mechanism until the padlock is removed.
 - iii) It shall not be possible to insert the padlock until the mechanism is completely latched closed.
- f) Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.
 - g) Each door shall be provided with a door holder of stainless steel located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.
3. Finish
- a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.
 - b) All exterior seams shall be sanded or ground smooth for neat appearance.
 - c) All surfaces shall undergo a chemical cleaning, phosphatizing or zirconization and sealing process 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.
 - d) The finishing system shall be applied without sags or runs for a pleasing appearance.
 - e) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches.
 - f) Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.
 - g) Unless otherwise specified, the color shall be Munsell No. 7GY3.29/1.5, dark green.
 - h) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide on request, certification that representative test panels, protected by the manufacturer's finish system, have passed the coating system performance criteria in section 5.5 of ANSI C57.12.28 as verified by an independent third party certifier, such as UL®.

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 pad-mounted gear. These ratings define the ability to close the interrupter switch 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 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 operated by means of stored-energy operators installed by the switch manufacturer.
- c) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.
- d) Interrupter switches shall be provided with a single-arm blade construction with parallel current paths for each phase for circuit

closing including fault-closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades that can become out of sequence with a main blade shall not be permitted.

- e) Interrupter switch blade supports shall be permanently fixed in place in a unified hinge contact assembly utilizing a louvered contact configuration that provides expansion and, therefore, increased pressure at the contact transfer point for a stable interface during momentary currents.
- f) Switch-blade hinge contacts that have wiping contacts directly connected to switch terminals and can be pulled apart by cable connected to the switch terminals are specifically prohibited, such designs can present potential arcing faults if cables are pulled.
- g) Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with essentially no external arc or flame.
- h) To increase contact separation speed, interrupter switch contacts on both sides of the arcing area shall be spring assisted to reduce arcing time and to rapidly increase the dielectric gap.
- i) To further insure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on blade travel to insure arc extinction.
- j) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.
- k) Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

The following optional features may be specified:

- l) Bracket-mounted distribution-class surge arresters, metal-oxide type (specify rating), shall be provided at all source switch terminals.
 - m) Switch terminals shall be provided with adapters to accommodate two cables per phase.
 - n) Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each interrupter switch compartment and (with or without, select one) a viewing window in the door.
 - o) Mounting provisions to accommodate LED-Type fault indicators. Holes for such fault indicators shall be plugged with a tamper-resistant arrangement for shipment.
 - s) Cable supports - recommended for cables 350MCM or larger and for all parallel cable applications.
2. Fuses
- a) Fuses shall be solid-material power fuses or current-limiting fuses as specified by the equipment purchaser.
 - b) Fuse-mounting jaw contacts for 15kV and 25kV applications shall incorporate an integral load-interrupter that shall comply with all the preferred and optional test requirements in IEEE C37.74 to permit live switching of fuses with a hookstick equipped with a grapple tool and shall have a 3-time duty-cycle fault-closing capability at the interrupting rating of 22,400 amperes symmetrical.

Note - 35kV fuse mountings are not available with an integral load-interrupter.

- 1) The integral load-interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.
 - 2) The integral load-interrupter shall be in the current path continuously only during circuit interruption. Auxiliary blades or linkages shall not be used.
 - 3) Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.
 - 4) The integral load-interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.
 - 5) Internal moving contacts of the integral load-interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
 - 6) Circuit interruption shall take place completely within the integral load-interrupter with essentially no external arc or flame.
 - 7) The integral load-interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
 - 8) Integral load-interrupters for fuses shall have a three-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse at the applicable voltage (14.4kV or 25kV). The duty-cycle fault-closing capability defines the level of available fault-current into which the fuse can be closed the three-times without a quick-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load-interrupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.
 - 9) To increase contact separation speed, integral load-interrupter contacts on the source side of the arcing area shall be spring assisted to retract and, thereby, reduce arcing time and to rapidly increase the dielectric gap.
 - 10) To further insure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on blade travel to insure arc extinction.
 - 11) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.
- c) Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.
 - d) Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall

equal or exceed the short-circuit ratings of the pad-mounted gear.

- e) Fuse-mounting interrupter housing shall be provided with a target that protrudes and becomes visible only after the fuse has become fully latched, secured, closed and ready for opening.
- f) Fuse-mounting interrupter housing shall incorporate a mechanical latching arrangement that shall capture the fuse contact rod on closing. On opening, the latching arrangement shall not release until after the circuit has been interrupted. The mechanical latching arrangement shall make certain that the fuse-contact rod does not rely solely on friction to keep the contacts engaged and to avoid premature contact separation during the circuit interrupting sequence.

E. Labeling

1. Hazard-Alerting Signs & Labels

- a) All external doors providing access to high voltage shall be provided with suitable hazard-alerting signs.
- b) The inside of each door providing access to high voltage shall be provided with a "Danger-High Voltage – Keep Out – Qualified Persons Only" sign.
- c) Each barrier providing access to an interrupter switch shall be provided with a sign indicating that "Switch Blades May Be Energized in Any Position" on both sides.
- d) Both sides of each barrier providing access to a fuse shall be provided with a sign indicating that "Fuses May Be Energized in Any Position".
- e) Any barriers used to guard against access to energized live parts shall be provided with a "Danger" sign on both sides.
- f) Dual-purpose barriers shall be provided with a label indicating that such barriers shall not be left inserted into the open gap for more than one week.
- g) Doors to fuse compartments shall include a label illustrating the correct latched condition for the integral load interrupter.
- h) Doors to fuse compartments shall include a label illustrating correct opening/closing switching operation for fuses with integral load interrupters.
- i) Removable barriers shall include a label stating that barrier should not be removed when the equipment is energized.

2. Nameplate, Ratings Labels, & Connection Diagrams

- a) The outside of both the front and back shall be provided with nameplates indicating the manufacturer's name, catalog number, serial number, and date of manufacture.
- 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 capability and amperes, short-time, (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).
- c) A three-line connection diagram showing interrupter switches, fuses and bus along with the manufacturer's model number shall be provided on the inside of both the front and rear doors, and on the inside of each switch operating hub access cover.

F. Accessories

- 1. Furnish fuse components of the type specified by the purchaser. No fuse units shall be supplied unless actually noted by the purchaser in the specifications available to the switchgear manufacturer at the time of quotation.
- 2. A fuse handling tool as recommended by the fuse manufacturer shall be furnished if noted by the purchaser in the specifications.