

# STANDARD SPECIFICATION FOR TYPE PLD LIVE-FRONT/DEAD-FRONT PAD-MOUNTED SWITCHGEAR 15kV • 25kV

## A. General

### 1. Product

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

### 2. Assembly

The outdoor pad-mounted switchgear shall consist of a single self-supporting enclosure, containing live-front, three-phase, group-operated interrupter switches and three-phase sets of dead-front, single-pole fuse positions with the necessary bus-work and components, all completely factory assembled and tested.

### 3. Coordination

To ensure a completely coordinated design, the pad-mounted switchgear shall be integrally designed and produced by the manufacturer of the basic switching equipment.

### 4. Ratings

The ratings for the integrated pad-mounted switchgear enclosure assemblies shall be as follows:

System Voltage Class		
	15kV	25kV
kV, Nominal	14.4V	25kV
kV, Maximum Design	17.5V	27kV
kV, BIL	95kV	125kV
Main Bus Continuous Amps	600 ❶	600 ❶
Switch Load-Interrupting Amps	600 ❷	600 ❸
Switch Fuse Load-Interrupting Amps	200	200
Switch Short-Circuit Amps ❹		
Amps, RMS Symmetrical	25kA	25kA
Peak Withstand Current	65kA	65kA
MVA 3-Phase Symmetrical at Rated Nominal voltage	620	1080
Fault Close Amps, RMS, Asym, 3-Time Duty Cycle ❺	40kA ❻	40kA

- ❶ 1200 ampere bus is also available
- ❷ 1200 ampere switches are also available
- ❸ 900 ampere switches are also available
- ❹ These are nominal ratings. Integrated pad-mount unit may be limited by fuse ratings as shown below. Please refer to the fuse ratings chart to select the proper fuse.
- ❺ The three-time duty cycle fault-closing rating means that the switch can be closed three times into rated fault and interrupt its rated load.
- ❻ One-time fault close rating of 61kA for 1200 amp design.

Fuse Ratings				
Fuse Manufacturer	Fuse Type	Three-Phase MVA Sym	Amps RMS Asym ❶	Cont. Amps
14.4 kV Nominal Voltage				
S&C	SM-4	310	20,000	200
S&C	SMU-20	350	22,400	200
S&C	SM-5†	—	—	—
Eaton (Cutler-Hammer)	DBU	350	22,400	200
Cooper	CMU	350	22,400	200
Cooper (M-E) ❷	NX	620	40,000	100*
Cooper (CT) ❷	X-Limiter	620	40,000	140
Thomas & Betts ❷	Hi-Tech	620	40,000	140
25 kV Nominal Voltage				
S&C	SM-4†	540	20,000	200
S&C	SMU-20	540	20,000	200
S&C	SM-5†	—	—	—
Eaton (Cutler-Hammer)	DBU	540	20,000	200
Cooper	CMU	210	20,000	200
Cooper (M-E) ❷	NX	1,080	40,000	40
Cooper (CT) ❷	X-Limiter	1,080	40,000	40
Thomas & Betts ❷	Hi-Tech	1,080	40,000	50

- ❶ The fuse mounting can withstand rated fault amperes up to three times and remain operable and able to carry its rated load current. For rating applicable to fault-closing capability of the separable connector (elbow), refer to the elbow manufacturer.
- ❷ Maximum current rating of the fuse mounting is 22,400 amperes, RMS, asymmetrical. Fuse mounting ratings can be increased to the fuse-interrupting rating ONLY if the current-limiting fuse limits the let-through current to a value equal to, or less than, the short-circuit rating of the fuse mounting. Refer to current-limiting fuse manufacturers for specific let-through values.
- \* 100 and @ 13.5kV max or 80 amp @ 15kV
- † 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.
- ‡ SM-5 fuses cannot be used in conjunction with dead-front fuse panels.

## 5. Certification of Ratings:

The manufacturer shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated pad-mounted switchgear assembly as rated.

The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted switchgear assembly, consisting of the switch and fuse components in combination with the enclosure. This certification of the integrated unit shall include testing the pad-mounted switchgear to the fault-close requirements of the specifications to assure the bus support system and components are adequate.

**Specifications must be verified by factory.**

## 6. 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 Electric 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) Applicable portions of IEEE C37.74 covering the design and testing of distribution switchgear, components, and ways.
- d) Applicable portions of IEEE-386 (formerly ANSI C119.2) covering separable cable connections.

## 7. Enclosure Design

To ensure a completely coordinated design, the pad-mounted switchgear shall be constructed in accordance with the minimum construction specifications required to provide adequate electrical clearances and adequate space for operation of the unit and any required handling of components.

In establishing the requirements for the enclosure design, consideration shall be given to all relevant human factors, such as controlled access and tamper resistance, as well as environmental factors, such as ingress of air-borne contamination and any ventilation which may be necessary for control of moisture and condensation.

## B. Construction – Assembly

### 1. Insulators, Bushings, and Bushing Wells

The pad-mounted switchgear insulators, bushings, and bushing wells shall have the following material characteristics and restrictions:

- 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 to applicable ANSI and IEEE standards.
- f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator, bushing, and bushing well to provide maximum resistance to power arcs. Ablation due to high temperature 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 insulating components during installation or maintenance of the pad-mounted gear shall expose material of the same composition

and properties so that insulating components with minor surface damage or imperfections need not be replaced.

- g) Each insulator, bushing, and bushing well shall be x-rayed to assure it is essentially void-free. An alternative testing method may be used only by approval of the engineer.
- h) Conductor rods of bushings and bushing wells shall be of all copper with silver flash and threaded studs.

### 2. High Voltage Bus

- a) Bus and interconnections shall consist of bare aluminum bar of 56% IACS conductivity with an oxide-inhibiting agent at all bus joints.
- b) Bus and interconnections shall withstand the stresses associated with short circuits up through the maximum rating of the pad-mounted gear, including proper allowance for transient conditions.
- c) Bolted aluminum to aluminum connections shall be made with a suitable number of non-corrosive bolts, with two Belleville spring washers per bolt, one under the bolt head and one under the nut, or with a wide-flange head 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 torque to assure good electrical connection.
- 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.

The following special features may be specified.

- e) 1200 ampere bus
- f) Copper bus

### 3. Ground Connection Pads

- a) A ground connection pad shall be provided in each termination compartment of the pad-mounted gear.
- b) The ground connection pad shall be constructed of 1/4" thick, stainless steel and have a NEMA 2-hole pattern for ground connections. The pad shall be welded to the enclosure and shall have a short-circuit rating equal to that of the integrated assembly.
- c) Ground studs shall be provided in each live-front switch compartment.
- d) A full-width copper-grounding rod shall be provided in each dead-front fuse-termination compartment.

## C. Construction – Enclosure & Finish

### 1. Enclosure

- a) The pad-mounted enclosure shall be of unitized construction (not structural frame and bolted sheet) to maximize strength, minimize weight, and inhibit internal corrosion.

- b) The basic material for the enclosure, roof, and doors shall be 11-gauge, hot rolled, pickled and oiled steel.
- c) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. A welding process shall be employed that eliminates alkaline residues and minimizes distortion and spatter.
- 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) In consideration of tamper resistance, the enclosure shall conform to, or exceed, the requirements of ANSI/IEEE C57.12.28.
- h) A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to reduce condensation of moisture thereon. The roof shall be removable with bolts accessible in termination compartments.
- i) Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A protective material shall be placed between the lifting tabs and the enclosure to prevent the tabs from scratching the enclosure finish. This material shall be non-hygroscopic to prevent moisture from being absorbed.
- j) To prevent moisture ingress, the roof shall be one-piece construction and shall not include any gasketed joints or any ungrounded weld butt joints exposed to the exterior.
- k) The roof shall be removable, with bolts accessible in the cable termination compartments.
- l) A closed-cell gasketing material shall be placed on the bottom flange as a protective interface between the steel enclosure and the mounting pad.

#### The following optional features may be specified

- m) Stainless steel enclosure, roof, and doors.
- n) A steel (specify compartmented or non-compartmented) base spacer shall be provided to increase the elevation of the live parts in the pad-mounted gear above the mounting pad by (specify -6, 12, 18, 24) inches.

#### 2. Barrier Assembly

Insulating barriers shall be provided in each switch and fuse compartment as required to achieve necessary insulation levels. This barrier system shall be constructed of fiberglass-reinforced polyester (NEMA rated GPO-3).

- a) Interphase and end barriers of GPO-3 shall be provided for each interrupter switch where required to achieve BIL ratings.
- b) Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall provide against

inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps (the alternate and temporary, "slide-in" position) 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)

Note – The barrier should not be left in the alternate slide-in position for more than one week.

- c) Full-length steel barriers shall separate side-by-side compartments.

#### The following optional feature may be specified

- d) Clear polycarbonate may be substituted for GPO-3 in the dual-purpose front barriers for the interrupter switches.

#### 3. Doors

- a) Doors shall be constructed of 11-gauge hot-rolled, pickled and oiled sheet steel.
- 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 a minimum of three hinges, stainless steel or other inherently non-corrosive material, each with stainless-steel hinge pins. The hinge pins shall be secured in place to guard against tampering.
- d) One active and one passive door shall be provided in the case where there are two adjacent doors. In consideration of controlled access and tamper resistance, each active door shall be equipped with a positive-action three-point auto-latch mechanism and padlock hasp.
- e) Each active door shall be equipped with an automatic three-point latching mechanism. This 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.
- f) Each active door shall be provided with a hinged stainless-steel cover over the operating bolt. The cover shall be padlockable and shall incorporate a hood to protect the padlock shackle from tampering and access to the operating bolt.
- g) Each door-latch operating bolt shall be a recessed pentahead bolt (hex-head optional) for security.
- h) Each passive door shall be independently secured (bolted or latched) to the enclosure.
- i) Each door shall be provided with a stainless-steel door holder (or "wind brace") located above the door opening. These holders shall be hidden from view when the door is closed. It shall not be possible for the holders to swing inside the enclosure.

#### 4. 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 in to 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 under-film propagation of corrosion.
- d) The finishing system shall be applied without sags or runs.
- e) After the enclosure is completely assembled and the components (bus, bushings, 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. 7GY 3.29/1.5, bell green.
- h) To ensure that the finishing system is capable of resisting corrosion, the manufacturer shall provide, on request, certification that the representative test panels, protected by the manufacturer's finish system, have passed the coating system performance requirements in section 5.5 of ANSI C57.12.28 as verified by an independent third party certifier, such as UL®.
- 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.

### D. Construction - Internal 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 switchgear. 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 the interrupt rated current. Tests substantiating these ratings shall be performed in accordance with C37.74. Certified test abstracts demonstrating such ratings of the interrupter switches 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.

#### The following optional features may be specified:

- l) 1200 ampere loadbreak switches
- m) Bracket-mounted distribution-class surge arresters, metal oxide type (specify rating), shall be provided at all source switch terminals.
- n) Switch terminals shall be provided with adapters to accommodate two cables per phase.
- o) Cable supports, accommodating #2 through 1000 MCM cables. Supports are recommended for all applications of cable 750 MCM or larger, unless other cable supporting methods are used.
- p) 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.

- q) Mounting provisions to accommodate LED-Type fault indicators. Holes for such fault indicators shall be plugged with a tamper-resistant arrangement for shipment.

## 2. Fuse Compartments

- a) Fuse terminals are equipped with 200 ampere rated bushing wells designed to accept 200 ampere bushing inserts and shall have removable, silver-plated copper studs.
- b) Bushings and bushing wells shall have interfaces in accordance with ANSI/IEEE Standard 386 (ANSI Standard C119.2) to accept all standard separable insulated connectors and inserts. Parking stands are provided adjacent to each bushing and bushing well to accommodate horizontal feed-through bushings and standoff insulators.
- c) Fuse access panels shall have a mechanical interlock that guards against gaining access to the fuse before opening the load-break separable insulated connector at the fuse terminal.
- d) The fuse shall be accessible only when de-energized and isolated — for full-view non-loadbreak disconnection and removal with a shotgun stick. This mounting features positive latching in both the energized and de-energized positions. When latched in the open position, the de-energized fuse is electrically isolated and readily accessible to operating personnel for removal with full visibility of contact interfaces on both sides of the fuse.
- e) Access to the compartment containing energized components when fuses are being changed shall be blocked by a GPO-3 panel that is secured in position.
- f) Individual parking stands shall be provided for each fuse mounting to allow convenient installation of elbow accessories to accommodate grounding. A ground rod shall be installed across the full width of the fuse compartments for connecting of cable concentric neutrals. Fuse phases shall be equipped with cable guides to assist in cable training and to prevent cables from interfering with movement of the fuse-access panel.
- g) To provide maximum service life and to prevent corrosion of moving parts, all latches and pivots in the fuse-handling mechanism shall be either painted steel, stainless steel, or zinc-plated.

### The following optional features may be specified:

- h) Fuse storage hooks shall be provided on fuse-termination compartment access door(s). Each set of hooks shall allow the storing of three complete fuse assemblies for power fuses. Storage hooks shall be for two holders when current-limiting fuses are used.

## E. Labeling

### 1. Warning Signs

All active and passive doors shall be provided with an approved external "WARNING – HIGH VOLTAGE – KEEP OUT" sign.

### 2. Additional Hazard-Alerting Signs and Labels

- a) The inside of each door providing access to high voltage shall be provided with a "Danger—High Voltage — Keep Out — Qualified Persons Only" sign.
- b) 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.
- c) Any barriers used to guard against access to energized live parts shall be provided with a "Danger" sign on both sides.
- d) 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.
- e) Removable barriers shall include a label stating that barrier should not be removed when the equipment is energized.

### 3. Nameplates, Ratings Labels, & Connection Diagrams

- a) The outside of the active door on both the front and back shall be provided with nameplates indicating the manufacturer's name, serial number, catalog number, model number, and date of manufacture.
- b) The inside of each door shall be provided with a ratings label indicating the following: capacitor bank size in kVAR, voltage ratings, main-bus continuous current rating, short-circuit ratings (amperes RMS symmetrical at rated nominal voltage), the type of capacitor fuse and its rating, capacitor switch ratings, and approximate unit weight.
- c) A three-line connection diagram showing the bus, terminations, capacitors, capacitor switches, fuses, reactors (if applicable) and locations of the VTs (or PTs) will be provided on the inside of the each door.

## F. Accessories

End fittings or holders, and fuse units or refill units for original installation, as well as spare fuse unit or refill unit for each fuse mounting, shall be furnished in accordance with the client's requirements when specified.



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**Specifications must be verified by factory.**

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