

1.0 GENERAL

- 1.01 The circuit-switcher shall conform to the following specification.
- 1.02 The circuit-switcher shall be an outdoor, three-pole device incorporating single-gap SF₆ gas-filled puffer-type interrupters driven by a single, stored-energy mechanism located within a ground-level operator.
- 1.03 The circuit-switcher shall be configured with (*select appropriate description*)
- (a) horizontal interrupters and vertical-break power-operated disconnect.
 - (b) vertical interrupters and side-break power-operated disconnect.
 - (c) vertical interrupters without disconnect.
 - (d) horizontal interrupters without disconnect.



1.04 The ratings and phase spacing for the circuit-switcher shall be as designated below.

kV, Nominal	[] ¹
kV, Maximum.	[] ¹
kV, BIL	[] ¹
Phase Spacing, Inches	[] ¹
Amperes, Continuous.	[] ¹
Amperes, Peak	[] ²
Amperes, RMS, One-Second	40,000
Amperes, RMS, Fault-Closing, Duty-Cycle, One-Time.	40,000
Amperes, RMS, Interrupting	

List only those duties which are required for the application.

Primary Faults:

69 kV through 138 kV	[] ¹
161 kV through 230 kV	20,000
Transformer Secondary Faults	4,000 ³

Load Splitting (Parallel or Loop Switching) []¹

Load Dropping []¹

For line dropping through 138 kV:

 Line Dropping. 400

For line dropping at 161 kV:

 Line Dropping. 320

For cable dropping through 138 kV:

 Cable Dropping (Charging Current) 400

For cable dropping at 161 kV:

 Cable Dropping (Charging Current) 320

For single shunt capacitor banks only—grounded banks through 138 kV or ungrounded banks through 115 kV:

Capacitor-Bank Switching. 400

For grounded reactors through 138 kV or ungrounded reactors at 69 kV:

Shunt Reactor Switching. 600

Interrupting Time, Cycles, Maximum.6

¹ Specify values from one of the lines in the “SELECTION OF VOLTAGE CURRENT AND INTERRUPTING RATINGS AND PHASE SPACINGS” table on page 3.

² Specify 130,000 for Models 2010, 2030, and 2040 with 25-kA primary fault interrupting. Specify 104,000 for Model 2020 at all fault interrupting ratings and all 40-kA primary fault interrupting models.

³ For 161-kV and 230-kV models, the secondary fault interrupting rating is 2000 A between –40°C and –30°C.

SELECTION OF VOLTAGE CURRENT AND INTERRUPTING RATINGS AND PHASE SPACINGS

Rating, kV			Continuous Current, Amperes	Primary-Side Interrupting, kA	Phase Spacing, Inches
Nominal	Maximum	BIL			
69	72.5	350	1200, 2000•	25, 40• ‡ †	48, 84
115	121	550	1200, 2000•	25, 40• ‡ †	84, 102
138	145	650	1200, 2000•	25, 40• ‡ †	84, 102
161	169	750	1200	20§	102, 120
230	242	900	1200	20§	120

- 2000-ampere Series 2000 Circuit-Switchers not available in 40-kA primary-side fault-interrupting rating, and vice versa.
- ‡ 40-kA primary-side fault-interrupting design has only been tested for use in transformer protection applications.
- † For 25-kA models, the primary fault interrupting rating is 20 kA at temperatures between -40°C and -30°C .
- § For 161-kV and 230-kV models, the primary fault interrupting rating is 15 kA at temperatures between -40°C and -30°C .

1.05 The circuit-switcher shall perform as intended at temperatures from -40°C through $+40^{\circ}\text{C}$ at wind loadings through 90 miles per hour, and at altitudes through []¹ feet.

SELECTION OF MAXIMUM ALTITUDE

System Voltage, kV, Nominal ↓	Maximum Altitude, Feet	
	Switching Duty →	
	Ungrounded Shunt Reactor Banks	All Other Applicable Duties
69	7,500	10,000
115	NA	10,000
138, 161	NA	7,500
230	NA	5,000

NA: Not applicable.

¹ Specify applicable value. See "SELECTION OF MAXIMUM ALTITUDE" table.

- 1.06 The circuit-switcher shall be furnished with mounting pedestals of 12-inch square steel-tube construction, galvanized internally and externally and of []¹ height. Galvanized steel anchor bolts are to be furnished by []².
- 1.07 The circuit-switcher, when installed on its mounting pedestals using the circuit-switcher manufacturer's recommended anchor bolts and with flexible-conductor connections at all six terminal pads, shall be capable of withstanding seismic loading of 0.2 g ground acceleration in any direction, as well as withstanding wind loadings specified in paragraph 1.05, and of performing as intended during such loadings and afterward.

For models with power-operated disconnect:

- 1.08 Integral Disconnect
- (a) The disconnect shall be integral with the interrupters. Arrangements utilizing a separate three-pole disconnect switch mounted on the circuit-switcher base, and having disconnect-switch terminal pads jumpered to the circuit-switcher terminal pads, shall not be acceptable.
- (b) The integral disconnect shall conform to or exceed the applicable portions of the following standards, as last revised, unless otherwise specified herein:
- ANSI C37.30, ANSI C37.32, ANSI C37.34,
NEMA SG6, NEMA 107, IEC 129, IEC 265, IEC 694.
- (c) Disconnect-blade contacts shall be of the high-pressure type, self-aligning and self-wiping, and designed to ensure effective contact and low contact resistance. Contact pressure shall not exceed the safe working value for the contact materials and shall cause no abrasion or scoring of the contacts. The disconnect-blade contacts shall be silver-to-silver. Silver inserts or silver strips, if used, shall be silver-brazed to contact supports. The shape and materials used for the disconnect-blade contacts shall be such that there will be no noticeable galling of the contact metals after the circuit-switcher has been subjected to a mechanical-operations test consisting of 5000 opening and 5000 closing operations (1500 opening and 1500 closing operations for 161-kV and 230-kV models, and 2000 opening and 2000 closing operations for 40-kA models).
- (d) The integral disconnect shall be capable of opening and closing without hesitation under 3/4-inch ice formation (models rated 161 kV and 230 kV shall be capable of opening without hesitation under 3/4-inch ice formation and of closing without hesitation under 1/2-inch ice formation).
- (e) The design of the disconnect operating mechanism shall be such that the blades are positively toggled in the fully closed position.

¹ Specify 96-inch, 120-inch, 144-inch, 168-inch, 192-inch, 216-inch, or 240-inch, as required.

² Specify either the circuit-switcher manufacturer or the purchaser, as applicable.

- 1.09 Each circuit-switcher, including all insulators and accessory equipment, shall be completely assembled and adjusted at the factory before shipment.
- 1.10 The following production tests shall be performed on each circuit-switcher before shipment:
- (a) Leak test: Each interrupter shall be subjected to a test to verify an overall leak rate of less than .015 ounce/year.
 - (b) Dielectric test: The completely assembled and wired operator control circuit shall be given a dielectric test at 1500 volts ac for one second.
 - (c) Operating speed test: Each circuit-switcher shall be completely assembled and checked for proper opening and closing speed and simultaneity.
 - (d) Mechanical operations test: Each circuit-switcher shall be closed and opened at least 50 times at high speed by means of its associated operator to verify proper performance of the complete assembly.
 - (e) Final leak test: Upon completion of the mechanical operations test specified in paragraph 1.10 (d), each interrupter shall again be subjected to a test to verify an overall leak rate of less than .015 ounce/year.
- 1.11 Pre-assembly for shipment
- For models with horizontal interrupters:*
- Circuit-switcher pole-units shall be shipped completely pre-assembled.
- For model with vertical interrupters and side-break power-operated disconnect:*
- Each circuit-switcher shall be shipped with the insulating support columns and disconnect-end insulators pre-assembled to the pole-unit bases.
- For model with vertical interrupters and without disconnect:*
- Each circuit-switcher shall be shipped with the insulating support columns pre-assembled to the base.
- 1.12 The manufacturer shall provide inspection recommendations which, if conformed with, will help ensure the circuit-switcher's continued proper performance. These inspection recommendations shall include a schedule and procedures for inspecting all of the key circuit-switcher components.
- 1.13 The manufacturer shall warrant to the original purchaser for a period of 5 years from the date of shipment that the equipment provided will be of the kind and quality specified herein and will be free of defects of workmanship and material.

2.0 CONSTRUCTION

2.01 Interrupters

- (a) Interrupters shall be factory-filled to full pressure with SF₆ of carefully controlled purity, under controlled conditions, and then permanently sealed. Field filling—either through individual fill ports or through a common fill port connected to a manifold—shall be neither necessary nor possible, thus eliminating the risk of contaminating the interrupting medium.
- (b) The interrupting medium of each interrupter shall be isolated from that of the other interrupters and shall be isolated from the insulating support columns as well, thus eliminating the need to leak-test these other components or to remove them, should interrupter replacement become necessary.
- (c) A go/no-go indicator shall be furnished to show the presence of adequate gas pressure. If remote gas-density monitoring is required, pressure and temperature sensors shall be mounted inside the interrupter to ensure an accurate measurement of the gas density.
- (d) A built-in, precision pressure-relief device shall be furnished.
- (e) Fully pressurized interrupters shall maintain the circuit-switcher's rated dielectric withstand values when open.

2.02 Operator and Power Train

- (a) For both opening and closing operations, all three interrupters shall be driven by a single stored-energy mechanism in an operator mounted at a convenient height for access. Power trains utilizing a separate stored-energy mechanism for each interrupter, operated by rotating an associated support insulator and requiring individualized adjustment to ensure close tripping simultaneity, shall not be acceptable.
- (b) The operator shall directly drive the interrupters open and closed through a completely enclosed high-speed power train leading from the top of the operator, through a horizontal interphase linkage, to reciprocating insulated operating rods which pass through the center of insulating support columns. Permanently lubricated bearings shall be used throughout the power train. Insulating support columns shall be filled with a lubricated dielectric filler which will prevent contamination from affecting the dielectric integrity of the insulated operating rod or the interior of the column. Each insulating support column shall be provided with an aerator to prevent water being pumped-in due to pressure differentials caused by temperature cycling.
- (c) The operating mechanism shall effect a smooth, thoroughly controlled movement throughout the entire opening and closing cycles and there shall be no noticeable deflection of rods, shafts, pipe linkages, connectors, operating levers, supports, and fittings.

- (d) A mechanical indicator, directly driven by the high-speed power train and mounted in such a manner as to be plainly visible from the ground, shall be furnished to show when the circuit-switcher is open or closed.
- (e) The circuit-switcher base(s) shall be of metal members of sufficient stiffness to prevent excessive deflection during operation. All steel materials utilized therein shall be galvanized.
- (f) The mechanism in the operator shall have an instantaneous trip-free capability. Should the circuit-switcher be inadvertently closed into a fault sensed by purchaser's relaying, the mechanism shall trip immediately. To accomplish trip-free operation, the mechanism shall utilize two spring assemblies—one for high-speed closing, one for high-speed opening—arranged so that both spring assemblies must be charged by the operator motor before the circuit-switcher can be closed.
- (g) The operator shall include the following features:
 - (1) Trip and close push buttons located inside operator enclosure.
 - (2) Manual trip lever, for tripping interrupters in the event control voltage has been lost.
 - (3) Charged and discharged indicators for stored-energy mechanism.
 - (4) Non-reset electric operation counter.
 - (5) Eight nonadjustable single-pole, double-throw auxiliary-switch contacts which follow the interrupters.
 - (6) Weatherproof, dust proof aluminum enclosure.

For models with power-operated disconnect:

 - (7) Manual charging handle, for opening disconnect after interrupters have been manually tripped open—in the event control voltage has been lost.

For models with power-operated disconnect:

 - (8) Decoupling mechanism which allows decoupling and locking of disconnect-blade power train in open position, permitting operational checkout of the interrupters, the stored-energy operating mechanism, and the relaying equipment without closing the high-voltage circuit.

For models with power-operated disconnect:

 - (9) Two individually adjustable auxiliary-switch contacts which follow the disconnect-blade power train and operator when coupled, and the operator only when decoupled.

(h) The operator shall be completely wired at the factory and ready for connection of external wiring to the operator terminal blocks.

(i) The operator, including its contactors, motor, and solenoids, shall be designed and connected for use with a []¹ control source. The operator space heater shall be designed and connected for use with a []² control source.

For models with power-operated disconnect:

(j) The operator shall be equipped with a power takeoff which drives a low-speed power train to rotate the insulating support columns, opening and closing the disconnect blades. The operator shall be arranged to ensure that the interrupters close only after the disconnect blades have closed, and that the disconnect blades open only after the interrupters have opened. Arrangements utilizing a separate operator to open and close the disconnect blades, and requiring user-dependent sequencing or mechanical or electrical interlocking of the two operators, shall not be acceptable.

For models with power-operated disconnect:

(k) The insulating support columns shall utilize rotating bearings of the tapered roller type, fully sealed, with the entire bearing cavity prepacked with grease.

3.0 DESIGN TESTS

3.01 The following design tests shall have been performed, and certified test reports shall be provided upon request:

- (a) Dielectric withstand: 60-hertz; impulse.
- (b) RIV.
- (c) Temperature rise.
- (d) Short-time current withstand: peak and one-second.
- (e) Current-interrupting performance: *(select as appropriate)*
 - (1) Primary and secondary faults.
 - (2) Load splitting (parallel and loop switching).
 - (3) Load dropping.
 - (4) Line and cable dropping (charging current).
 - (5) Capacitor bank and reactor switching.
- (f) Single-phase fault closing at rated voltage.
- (g) Three-pole ice performance: opening and closing.
- (h) Mechanical operations: complete three-pole circuit-switcher.

¹ Specify 48-volt dc, 125-volt dc, or 115-volt 60-hertz, as required.

² Specify 120-volt 60-hertz or 240-volt 60-hertz, as required.

4.0 ACCESSORY EQUIPMENT

4.01 The circuit-switcher shall be furnished with the following accessory equipment:

The following optional features should be specified as required.

- (a) Space-heater thermostat for operator.
- (b) Position-indicating LED lamps—one red, one green—located inside operator enclosure and wired in series with trip coil, for local indication of circuit-switcher position and operator trip-circuit continuity. *(This optional feature is not available in applications utilizing a circuit-switcher relay and control pack.)*
- (c) Trip-circuit-monitoring relay wired in series with operator trip coil for monitoring continuity of trip circuit; equipped with one normally open and one normally closed contact suitable for use with remotely located indicating lamps or alarms. *(This optional feature is not available in applications utilizing a circuit-switcher relay and control pack.)*
- (d) Loss of control power (ac/dc) voltage relay. Provides contacts for use in, for example, a user-furnished alarm system.
- (e) Duplex receptacle with ground-fault circuit interrupter and convenience-light lampholder with switch, located inside operator enclosure.
- (f) Eight additional nonadjustable single-pole, double-throw auxiliary-switch contacts in operator which follow the interrupters.
- (g) Local-remote selector switch, which prevents remote operation of operator when selector switch is placed in “local” mode as, for example, during circuit-switcher inspection.
- (h) Key interlock located inside operator enclosure. Key may be removed when interrupters are tripped, locking them open and disconnecting control circuit. Key may then be used to release interlock associated with []¹.
- (i) Remote gas-density monitor, which monitors the density of the SF₆ gas in each interrupter. System outputs include two alarm relays that actuate at pre-set densities, a system status alarm relay, 0 to 1 mA analog outputs for each interrupter, and a liquid crystal display inside the operator enclosure.

For models furnished with grounding switch:

- (j) Key interlock mounted on grounding-switch manual operating handle, to coordinate with key interlock specified in paragraph 4.01 (h) to guard against operating grounding switch with disconnect blades closed or with interrupters closed.

For models with power-operated disconnect:

- (k) Grounding switch, manual, three-pole, group-operated, 64,000 amperes, RMS, momentary rating, with blades parallel to pole-unit bases when in open position, for grounding jaw-contact terminal pads.

¹ Specify grounding switch or other equipment.

For models with horizontal interrupters:

- (l) Grounding switch, manual, three-pole, group-operated, 64,000 amperes, RMS, momentary rating, with blades parallel to pole-unit bases when in open position, for grounding interrupter-end terminal pads.

For model with vertical interrupters and without disconnect:

- (m) Grounding switch, manual, three-pole, group-operated, 64,000 amperes, RMS, momentary rating, with blades perpendicular to base when in open position, for grounding lower terminal pads. *(This optional feature is not available if the optional bypass accessory specified in paragraph 4.01(n) is furnished.)*

For models with horizontal interrupters:

- (n) Bypass accessory, single-pole, stick-operated, set of three, 1200 amperes continuous, 61,000 amperes, RMS, momentary rating, to permit operational checkout of the circuit-switcher and the relaying equipment without opening the high-voltage circuit.

For model with vertical interrupters and without disconnect (through 138 kV only):

- (o) Bypass accessory, single-pole, stick-operated, set of three, 900 amperes continuous, 40,000 amperes, RMS, momentary rating, to permit operational checkout of the circuit-switcher and relaying equipment without opening the high-voltage circuit. *(This optional feature is not available if the optional grounding switch specified in paragraph 4.01(l) is furnished.)*

For models with vertical interrupters:

- (p) Enhanced-visibility low-gas-pressure indicator, to increase visibility of the low-gas-pressure indicator when viewed from within close proximity to the base of the switch.

