

Medium-voltage power distribution and control systems > Switchgear >

VacClad-W 5–15 kV, arc-resistant metal-clad medium-voltage switchgear

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General Description

Eaton's VacClad-W metal-clad switchgear with Type VCP-W vacuum breakers provides centralized control and protection of medium-voltage power equipment and circuits in industrial, commercial and utility installations involving generators, motors, feeder circuits, and transmission and distribution lines.

Eaton has been manufacturing arc-resistant metal-clad switchgear since 1990. Eaton was the first major North American manufacturer to design, test and manufacture arc-resistant switchgear in accordance with EEMAC G14.1. We now offer Type 2 and 2B arc-resistant switchgear assemblies, designed and tested in accordance with the IEEE C37.20.7, with Type VCP-W drawout vacuum circuit breakers.

Eaton's VacClad-W metal-clad arc-resistant switchgear with Type VCP-W vacuum circuit breakers can be configured in various combinations of breakers and auxiliaries to satisfy user's application requirements. One-high and two-high arrangements can be provided when required.

Ratings

Maximum Voltages:

4.76 kV, 8.25 kV, 15 kV

Interrupting Ratings:

4.76 kV: Up to 63 kA

8.25 kV: Up to 63 kA

15.0 kV: Up to 63 kA

Continuous Current—Circuit Breakers:

1200 A, 2000 A, 3000 A (5 and 15 kV)

4000 A Forced cooled (5 and 15 kV)

Continuous Current—Main Bus:

1200 A, 2000 A, 3000 A (5 and 15 kV)

4000 A (5 and 15 kV)

Note: Continuous currents above 4000 A, contact Eaton.

Certifications

- UL® and CSA® listings are available for many configurations; consult Eaton

Additional VacClad-W Metal-Clad Switchgear Offerings

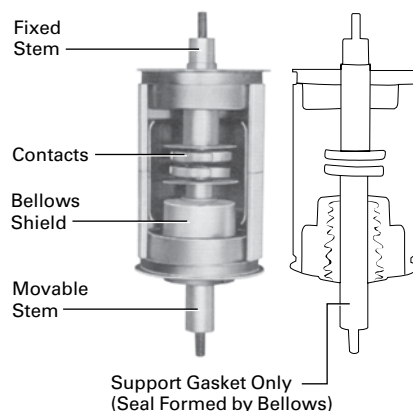
VacClad-W metal-clad switchgear is also available in the following designs:

- 5–15 kV
- 5 kV 26-inch narrow wide
- 27 kV
- 27 kV arc resistant
- 38 kV
- 38 kV arc resistant

Refer to the Eaton website for additional details.



VCP-W Circuit Breaker



*Cut-Away View of Vacuum Interrupter
(Enlarged to Show Detail)*

Arc-Resistant Switchgear—Accessibility Types

Arc-resistant switchgear performance is defined by its accessibility type in accordance with IEEE test guide C37.20.7 as follows:

Type 1—Switchgear with arc-resistant designs or features at the freely accessible front of the equipment only.

Type 2—Switchgear with arc-resistant designs or features at the freely accessible exterior (front, back and sides) of the equipment only. (Type 2 incorporates Type 1.)

Type 2B—Switchgear with Type 2 accessibility plus arc-resistant in front of the instrument/control compartment with the instrument/control compartment door opened. (Type 2B incorporates Type 2.)

Eaton's 5/15 kV switchgear is designed and tested for IEEE Type 2B accessibility, and 27 and 38 kV switchgear is designed and tested to IEEE Type 2.



*Arc-Resistant Switchgear
with Plenum Installed*

Arc-resistant features are intended to provide an additional degree of protection to the personnel performing normal operating duties in close proximity to the equipment while the equipment is operating under normal conditions. The normal operating conditions for proper application of arc-resistant switchgear designs are as follows:

- All doors and covers providing access to high-voltage components are properly closed and latched
- Pressure relief devices are free to operate
- The fault energy available to the equipment does not exceed the rating of the equipment (short-circuit current and duration)
- There are no obstructions around the equipment that could direct the arc fault products into an area intended to be protected
- The equipment is properly grounded

The user should also refer to documents such as NFPA 70E, for safety training and safe work practices and methods of evaluating safe work distances from energized equipment based on the potential flash hazard, and use proper PPE when working on or near energized equipment with the door/cover opened or not properly secured.

Standards

Switchgear Assembly

Eaton's VacClad-W metal-clad arc-resistant switchgear meets or exceeds the following standards and test guides:

North American Documents

- IEEE C37.20.2 – Standards for Metal-Clad Switchgear
- IEEE C37.20.7 – Guide for Testing Metal-Enclosed Switchgear for Internal Arcing Faults

Canadian Documents

- CSA C22.2 No. 31-04 – Switchgear Assemblies
- EEMAC G8-3.2 – Metal-Clad and Station Type Cubicle Switchgear
- EEMAC G14-1 – Procedure for testing the resistance of metal-clad switchgear under conditions of arcing due to an internal fault. The G14-1 was the first North American testing guide introduced in 1987

Circuit Breakers

The Type VCP-W and VCP-WC vacuum circuit breakers, used in VacClad-W arc-resistant switchgear, meet or exceed all ANSI and IEEE standards applicable to ac high-voltage circuit breakers rated on symmetrical current basis, including but not limited to: C37.04, C37.06, and C37.09. Also available are type VCP-WG vacuum circuit breakers conforming to IEEE standard C37.013 for ac high-voltage generator circuit breakers.

Third-Party Certification

5 and 15 kV arc-resistant metal-clad switchgear assemblies can be provided with CSA (Canada or USA) or UL (USA only) listing. Contact Eaton for available ratings.

Arc-Resistant Metal-Clad Switchgear

Arc-resistant metal-clad switchgear also conforms to C37.20.2 and is tested as such for short time and momentary short-circuit withstand for through bolted fault. In addition, the enclosure is also tested in accordance with IEEE guide C37.20.7 for withstand against the effects of internal arcing faults as shown in **Figure 5.3-1**.

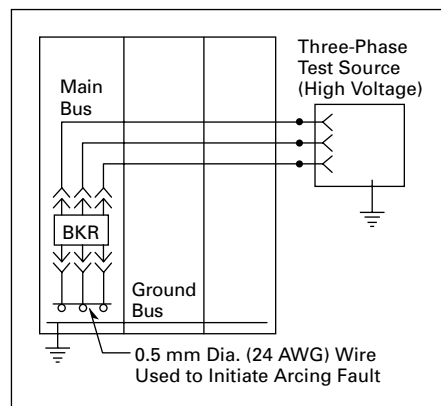


Figure 5.3-1. Arc-Resistant Switchgear Enclosure Internal Arcing Short-Circuit Withstand Test

Internal arcing faults are those faults occurring in air, phase-to-phase or phase-to-ground, within the confines of the switchgear enclosure. Arcing faults can occur within a switchgear compartment as a result of insulation failure or human error. The arcing fault produces a tremendous release of heat energy at the point of the fault, which heats and expands the air volume within the enclosure, and may decompose or vaporize materials exposed to an arc or involved in its path.

The effects of this type of fault vary depending on enclosure volume, arc duration, arc voltage, and available short-circuit current. If the switchgear is not designed and tested to withstand effects of internal arcing faults, its parts could blow away along with discharge of hot decomposed matter, gaseous or particulate, causing injury to personnel that may be present in its vicinity. Arc-resistant switchgear is designed to channel and control effects of the arcing fault and its enclosure is tested for withstand against such fault in accordance with IEEE guide C37.20.7.

Medium-Voltage Vacuum Circuit Breaker Features and Ratings

VacClad-W metal-clad arc-resistant switchgear is designed for use with Eaton's state-of-the-art medium-voltage vacuum type VCP-W (standard ANSI), VCP-WC (extra capability), and VCP-WG (generator) circuit breakers. Refer to **Table 5.3-6**, **Table 5.3-9** and **Table 5.3-11** for complete list of available ratings.

Arc-Resistant Enclosure and Arc Exhaust

VacClad-W arc-resistant switchgear is designed to withstand effects of internal arcing faults up to its rated arc short-circuit current and duration. The arc-withstand capability of the switchgear enclosure is achieved by use of reinforced heavier gauge steel where needed, smart latching of doors and covers, and top-mounted built-in pressure relief system. Following are standard design features built into each arc-resistant switchgear assembly.

- The formed steel compartment design provides sealed joints under fault conditions. This prevents smoke and gas from escaping to other compartments, a condition that can occur with switchgear compartments designed with conventional flat bolted panels
- Integral, pressure release flap vents mounted on top of each individual vertical section provide for controlled upward release of arc created over-pressure, fire, smoke, gases and molten material out of the assembly without affecting structural integrity, and protect personnel who might be present in the vicinity of the switchgear
- The structure roof, including the pressure release flap vents, is drip proof. The design is made strong such that the roof can be “walked-on” when the gear is completely de-energized (for example, during installation)
- Since arc pressure is vented out through the top of each individual vertical section, the equipment damage is confined to individual structures, minimizing damage to adjacent structures

Circuit Breaker Compartment

- The levering mechanism is mechanically interlocked with the compartment door such that the door cannot be opened until the circuit breaker is opened and levered out to the test/disconnect position. This interlocking ensures that the levering of the circuit breaker into or out from the connected position is done with compartment door closed and latched, with no exposure to potential arc flash

- Easy access and viewing ports are provided on the door to allow operator to carry out normal functions with the door closed and latched, with no exposure to potential arc flash. Those functions include: Breaker levering and manual opening of the circuit breaker, viewing of open/close status of the breaker main contacts, viewing of charged/discharged status of the closing springs, viewing of mechanical operations counter, and breaker position

Auxiliary Compartments

VacClad arc-resistant 5/15 and 38 kV designs permit maximum of two auxiliary drawers in one vertical section. The 27 kV design permits maximum of only one auxiliary drawer per vertical section.

- Each auxiliary drawer is equipped with cell-mounted levering mechanism. The mechanism is mechanically interlocked with its compartment door such that the door cannot be opened and access to auxiliary drawer cannot be gained until the drawer is first levered out to the disconnected position. This interlocking ensures that the levering of the auxiliary drawer into or out from the connected position is done with compartment door closed and latched, with no exposure to potential arc flash
- A viewing window is provided on the door and on front panel of the drawer to allow viewing of the drawer position and the primary fuses
- In 5/15 kV designs, each auxiliary drawer can also accommodate a single-phase CPT rated up to 15 kVA, with primary fuses, or the drawer can also be configured as a fuse drawer with two or three primary fuses, and connected to a fixed mounted CPT (single-phase or three-phase 45 kVA maximum) in the rear of the structure
- In 27 kV designs, an auxiliary drawer can be configured as a fuse drawer with two primary fuses and connected to a fixed-mounted CPT (single-phase 25 kVA maximum) in the rear of the structure
- In 38 kV designs, fuse drawer can be provided with two primary fuses and connected to a fixed-mounted CPT (single-phase 25 kVA maximum) in the rear of the structure. Please note that in 38 kV designs, a fuse drawer requires a full vertical section, because it occupies the same compartment space as required for a circuit breaker

Control Compartments

The control compartment doors can be opened to access control wiring without having to de-energize the primary circuit. The control compartments have been tested to provide arc-resistant protection with its door opened under normal operating condition. Please note the control compartment door should be opened only for access to control wiring when needed, and should remain closed at all other times.

Relay Box on Breaker Compartment Door in 5/15 kV Switchgear

When needed for additional relays/instruments/controls, a relay box mounted on the breaker compartment door provides ample space for individual breaker relaying and controls. Access to control wiring or device terminals that are enclosed within the relay box does not require opening of the circuit breaker compartment door.

Arc Exhaust Wall and Arc Exhaust Chamber (Plenum)

Refer to Page 5.3-36.

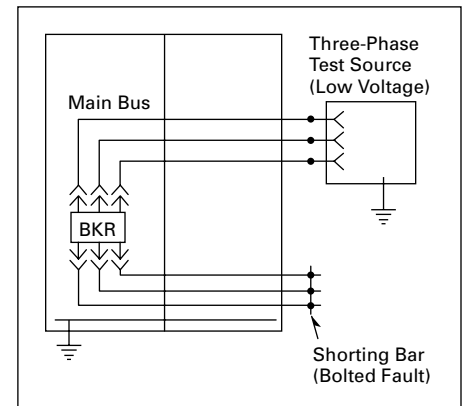


Figure 5.3-2. Metal-Clad Switchgear Short-Circuit and Momentary Withstand Tests

VacClad is Corona Free

Corona emissions within the standard VacClad switchgear assemblies have been eliminated or reduced to very low levels by special fabrication and assembly techniques, such as rounding and buffing of all sharp copper edges at the joints, employing star washers for bolting metal barriers, and using specially crafted standoff insulators for primary bus supports. By making switchgear assemblies corona-free, Eaton has made its standard switchgear more reliable.

5/15 kV Arc-Resistant Switchgear



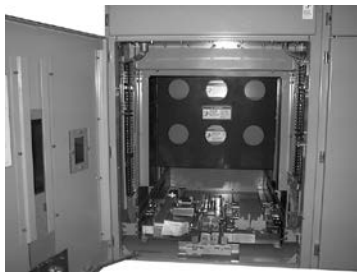
Front View— Type VCP-W 5/15 kV Arc-Resistant Switchgear (Plenum Above the Switchgear Not Shown)



5/15 kV Auxiliary Over Auxiliary



5/15 kV Breaker Over Breaker



Breaker Compartment



Breaker Shown Fully Withdrawn on Extension Rails



VTs Drawer— Shown Fully Withdrawn



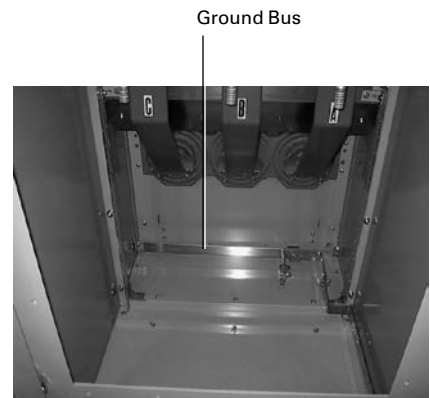
Fuse Drawer— Shown Fully Withdrawn



Rear View 5/15 kV VCP-W Arc-Resistant Switchgear



Rear View— Breaker Over Breaker Cable Termination



Rear View— Bottom Cable Compartment

Note: Application layouts and dimensions— refer to Page 5.3-31 to Page 5.3-40.

Arc-Resistant Switchgear Assembly Ratings

VacClad-W metal-clad arc-resistant switchgear is available for application at voltages up to 38 kV, 50 or 60 Hz. Refer to the table below for complete list of available ratings.

Table 5.3-1. VacClad-W Arc-Resistant Metal-Clad Switchgear ①②

Rated Maximum Voltage ③	(Ref.) Rated Voltage Range Factor K	(Ref.) Rated Short-Circuit Current I	Ratings per IEEE C37.20.2-2015						Enclosure Internal Arc Withstand				
			Insulation Level		Rated Main Bus Continuous Current ④	Rated Short-Time Short-Circuit Current Withstand (2-Second)	Rated Momentary Short-Circuit Current Withstand (10-Cycle) (167 ms)		Accessibility Type		Rated Arc Short-Circuit Withstand Current		Rated Arc Duration
			Power Frequency Withstand Voltage, 60 Hz, 1 Minute	Lightning Impulse Withstand Voltage [LIWV] (BIL)			kA rms	kV rms	kV Peak	Amperes	kA rms Sym.	kA Crest	
kV rms	kA rms	kV rms	kV Peak	Amperes	kA rms Sym.	kA Crest	kA rms Asym.	IEEE C3720.7	EEMAC G14-1	kA rms Sym.	kA Peak	Sec.	
4.76	1	25	19	60	1200, 2000, 3000, 4000	25	68	40	2B	—	25	65	0.5
	1.24	29			1200, 2000, 3000, 4000	36	97	58	2B	—	36	93.6	0.5
	1	40			1200, 2000, 3000, 4000	40	108	64	2B	—	40	104	0.5
	1.19	41			1200, 2000, 3000, 4000	49	132	78	2B	—	49	127.4	0.5
	1	50			1200, 2000, 3000, 4000	50	135	80	2B	—	50	130	0.5
	1	63			1200, 2000, 3000, 4000	63	170	101	2B	—	63	170	0.5
8.25	1.25	33	36	95	1200, 2000, 3000, 4000	41	111	66	2B	—	41	106.6	0.5
	1	50			1200, 2000, 3000, 4000	50	135	80	2B	—	50	130	0.5
15	1.3	18	36	95	1200, 2000, 3000, 4000	23	62	37	2B	—	23	59.8	0.5
	1	25			1200, 2000, 3000, 4000	25	68	40	2B	—	25	65	0.5
	1.3	28			1200, 2000, 3000, 4000	36	97	58	2B	—	36	93.6	0.5
	1	40			1200, 2000, 3000, 4000	40	108	64	2B	—	40	104	0.5
	1.3	37			1200, 2000, 3000, 4000	48	130	77	2B	—	48	124.8	0.5
	1	50			1200, 2000, 3000, 4000	50	135	80	2B	—	50	130	0.5
27 ③⑧	1	16	60	125	1200, 2000, 2500, 3000	16	43	26	2	B	16	41.6	0.5
	1	22			1200, 2000, 2500, 3000	22	60	35	2	B	22	57.2	0.5
	1	25			1200, 2000, 2500, 3000	25	68	40	2	B	25	65	0.5
	1	31.5			1200, 2000, 2500, 3000	31.5	85	51	2	B	31.5	81.9	0.5
	1	40			1200, 2000, 2500, 3000	40	108	64	2	B	40	104	0.5
38 ③	1	16	80	150	1200, 2000, 2500, 3000	16	43	26	2	B	16	41.6	0.5
	1	25			1200, 2000, 2500, 3000	25	68	40	2	B	25	65	0.5
	1	31.5			1200, 2000, 2500, 3000	31.5	85	51	2	B	31.5	81.9	0.5
	1.65	23			1200, 2000, 2500, 3000	35	95	56	2	B	35	91	0.5
	1	40			1200, 2000, 2500, 3000	40	108	64	2	B	40	104	0.5

① The switchgear assembly is designed for use with type VCP-W, VCP-WC and VCP-WG circuit breakers. However, please note that certain VCP-WC circuit breakers may have higher capabilities than required by ANSI standards. In such cases, switchgear assembly ratings as given in this table will apply.

② Switchgear assemblies can be supplied with UL/CSA label. Contact Eaton for availability.

③ 5–15 kV switchgear is supplied with a plenum. 27–38 kV switchgear is supplied with arc wall. For plenum requirements at 27 and 38 kV, contact Eaton.

④ Maximum continuous current rating for circuit breaker that can be supplied at 38 kV is 2500 A.

⑤ Please note that use of certain current transformers (for example, bar type CTs) and protective devices may limit the duration to a value less than 2 seconds.

⑥ These values exceed 2.6*K*I required by IEEE C37.20.2-2015.

⑦ These values exceed 1.55*K*I required by IEEE C37.20.2-2015.

⑧ 27 kV arc-resistant switchgear can be supplied in one-high configuration only.

Usual and Unusual Service Conditions

Usual Service Conditions

Usual service conditions for operation of metal-clad switchgear are as follows:

- Altitude does not exceed 3300 feet (1000 m)
- Ambient temperature within the limits of –30 °C and +40 °C (–22 °F and +104 °F)
- The effect of solar radiation is not significant

Applications Above 3300 Feet (1006 m)

Equipment utilizing sealed interrupting devices (such as vacuum interrupters) does not require derating of rated maximum voltage. The rated one-minute power frequency withstand voltage, the impulse withstand voltage and the continuous current rating must be multiplied by the appropriate correction factor in **Table 5.3-4** to obtain modified ratings that must equal or exceed the application requirements.

Note: Intermediate values may be obtained by interpolation.

Applications Above or Below 40 °C Ambient

Refer to ANSI C37.20.2, Section 8.4 for load current-carrying capabilities under various conditions of ambient temperature and load.

Unusual Service Conditions

Applications of metal-clad switchgear at other than usual altitude or temperature, or where solar radiation is significant, require special consideration. Other unusual service conditions that may affect design and application include:

- Exposure to salt air, hot or humid climate, excessive dust, dripping water, falling dirt, or other similar conditions
- Unusual transportation or storage conditions
- Switchgear assemblies when used as the service disconnecting means
- Installations accessible to the general public
- Exposure to seismic shock
- Exposure to nuclear radiation

Applications at Frequencies Less Than 60 Hz

Rated Short-Circuit Current

Based on series of actual tests performed on Type VCP-W circuit breakers and analysis of these test data and physics of vacuum interrupters, it has been found that the current interruption limit for Type VCP-W circuit breakers is proportional to the square root of the frequency. **Table 5.3-2** provides derating factors, which must be applied to breaker interrupting current at various frequencies.

Table 5.3-2. Derating Factors

Interrupting Current Derating Factors			
50 Hz	25 Hz	16 Hz	12 Hz
None	0.65	0.52	0.45

Rated Short-Time and Close and Latch Currents

No derating is required for short time and close and latch current at lower frequency.

Rated Continuous Current

Because the effective resistance of circuit conductors is less at lower frequency, continuous current through the circuit can be increased somewhat. **Table 5.3-3** provides nominal current rating for VCP-W breakers when operated at frequencies below 60 Hz.

Table 5.3-3. Current Ratings

Rated Continuous Current at 60 Hz	Nominal Current at Frequency Below 60 Hz			
	50 Hz	25 Hz	16 Hz	12 Hz
1200 A	1243	1410	1519	1589
2000 A	2075	2374	2573	2703
3000 A	3119	3597	3923	4139

Power Frequency and Impulse Withstand Voltage Ratings

No derating is required for lower frequency.

CTs, VTs, Relays and Instruments

Application at frequency other than rated frequency must be verified for each device on an individual basis.

Table 5.3-4. Altitude Derating Factors

Altitude Above Sea Level in Feet (m)	Altitude Correction Factor to be Applied to:	
	Voltage	Rated Continuous Current
3300 (1006) (and Below)	1.0	1.0
4000 (1219)	0.98	0.995
5000 (1524)	0.95	0.991
6000 (1829)	0.92	0.987
6600 (2012)	0.91	0.985
7000 (2137)	0.89	0.98
8000 (2438)	0.86	0.97
9000 (2743)	0.83	0.965
10,000 (3048)	0.80	0.96
12,000 (3658)	0.75	0.95
13,200 (4023)	0.72	0.94
14,000 (4267)	0.70	0.935
16,000 (4877)	0.65	0.925
16,400 (5000)	0.64	0.92
18,000 (5486)	0.61	0.91
20,000 (6096)	0.56	0.90

Circuit Breakers

VCP-W Circuit Breakers

Eaton's VCP-W medium-voltage circuit breakers offer the latest in vacuum technology, providing superior control and protection of medium-voltage power equipment in utility, industrial, commercial, mining and marine installations. Built in a state-of-the-art ISO® 9002 certified facility, they meet and exceed all ANSI and IEC requirements. Available in drawout configurations, Eaton's vacuum circuit breakers are a result of our ongoing commitment to research and development, which have resulted in significant breakthrough technologies. Each breaker is provided with its unique Quality Assurance Certificate that documents all tests and inspections performed.

VCP-W Standard Features

- Eaton's maintenance-free vacuum interrupters with visual contact erosion indicator
- Non-sliding/non-rolling V-Flex™ current transfer system
- Glass polyester insulation
- Front-accessible operating mechanism
- Electrically operated trip-free, spring stored energy mechanism
- Interlocks that prevent moving a closed circuit breaker into or out of the connected position
- Closing springs automatically discharge before moving the circuit breaker into or out of the enclosure
- Provisions for manual charging of closing springs
- Manual close and trip pushbuttons
- Operations counter
- Closing spring charged/discharged indicator
- Circuit breaker Open/Closed indicator
- Auxiliary switch with 2A/3B for dc and 1A/3B for ac spare contacts
- Spring charging motor, close coil, trip coil, latch check switch and anti-pump relay

VCP-W Circuit Breaker Ratings

- **Table 5.3-5** includes 5/15 kV circuit breakers rated on the basis of $K = 1.0$ in accordance with revised ANSI standards
- **Table 5.3-6** includes capabilities of traditional 5/15 kV circuit breakers rated on the basis of $K > 1.0$. Contact Eaton for availability of these circuit breakers

The following discussion provides a brief explanation of rated voltage range factor $K = 1$ and $K > 1.0$.

Discussion of changes in the Rated Voltage Range Factor, K, or "K-factor"

In 1997 and 2000 editions of ANSI C37.06, under Table 1, preferred values for the rated voltage range factor, K , were set to 1.0 for all indoor circuit breaker ratings. This was done because interrupting capabilities of today's vacuum circuit breakers are better represented by $K = 1.0$.

Unlike old air-magnetic and oil circuit breakers, today's vacuum breakers generally do not require a reduction in interrupting current, as the operating voltage is raised to rated maximum voltage, for example from 11.5 kV up to 15 kV. The interrupting capability of vacuum circuit breakers is essentially constant over the entire range of operating voltages, up to and including its rated maximum voltage.

The change was also made as a step toward harmonizing preferred ANSI ratings with the preferred ratings of IEC standards. It was further recognized that it is much simpler to select and apply circuit breakers rated on the basis of $K = 1.0$.

The change in the K value, however, in no way affects the ratings and capabilities of circuit breakers originally tested and rated on the basis of $K > 1$ in the earlier editions of C37.06. Existing circuit breakers, with ratings based on $K > 1.0$, are still perfectly valid, meet the latest editions of the standards, and should be continued to be applied as they have been in the past. The original $K > 1.0$ ratings are neither "obsolete" nor "inferior" to the new $K = 1.0$ ratings; they are just different.

The new 1997 and 2000 editions of ANSI standard C37.06 still include the earlier $K > 1$ ratings as Table A1 and A1A. The change from $K > 1.0$ to $K = 1.0$ should be implemented by manufacturers as they develop and test new circuit breaker designs. The change does not require, recommend or suggest that manufactures re-rate and re-test existing breakers to new standard.

And accordingly, Eaton continues to offer both circuit breakers rated on the traditional basis of $K > 1.0$ just as thousands of those breakers have been applied for variety of circuit switching applications worldwide, and also as Eaton develops new breakers, they are rated and tested to the new $K = 1$ ratings.

As a leader in vacuum interruption technology, Eaton continues to provide a wide choice of modern vacuum circuit breakers so that the user can select the most economical circuit breaker that can satisfy their circuit switching application.

Table 5.3-5. Available 5/15 kV VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards (Rated K = 1.0)
(Continued on next page)

Identification Drawout Circuit Breaker Type	Rated Values															
	Maximum Voltage (V)	Power Frequency ①	Insulation Level		Continuous Current ②	Short-Circuit Ratings (Reference C37.04-1999 and C37.06-2009 Except as Noted ③)						Transient Recovery Voltage Parameters are Based on TD-4				Interrupting Time
			Power Frequency Withstand Voltage (1 min.)	Lightning Impulse Withstand Voltage (1.2 x 50 μs)		Symmetrical Interrupting Current (I) ③	dc Component (% dc) ④	Asymmetrical Interrupting Current (I _t) ⑤	Closing and Latching Current (2.6 x I)	Short-Time Withstand Current ⑥	Peak Voltage (E ₂) = (u _c)	Time to Peak (T ₂ = T ₃ x 1.137)	TRV Rise Time (t ₃)	RRRV = u _c /t ₃ ⑦		
Units	kV rms	Hz	kV rms	kV Peak	A rms	kA rms sym	%	kA rms asym Total	kA Peak	rms	kV Peak	μsec	μsec	kV/μsec	ms	Cycles (60 Hz)
50VCP-W 25	4.76	60	19	60	1200 2000 3000	25	50	31	65	25	8.2	50	44	0.19	50	3
50VCP-W 40	4.76	60	19	60	1200 2000 3000	40	50	49	104	40	8.2	50	44	0.19	50	3
50VCP-W 50	4.76	60	19	60	1200 2000 3000	50	44	59	130	50	8.2	50	44	0.19	50	3
50VCP-W 63	4.76	60	19	60	1200 2000 3000	63	55	80	164	63	8.2	50	44	0.19	50	3
150VCP-W 25	15	60	36	95	1200 ⑧ 2000 3000	25	50	31	65	25	28 ⑧ 25.7	75	66	0.42 0.39	50	3
150VCP-W 40	15	60	36	95	1200 2000 3000	40	50	49	104	40	25.7	75	66	0.39	50	3
150VCP-W 50	15	60	36	95	1200 2000 3000	50	44	59	130	50	25.7	75	66	0.39	50	3
150VCP-W 63	15	60	36	95	1200 ⑧ 2000 ⑧ 3000 ⑧	63	55	80	164	63	28 ⑧	75	66	0.42	50	3

- ① All circuit breakers are tested at 60 Hz; however, they can also be applied at 50 Hz with no derating.
- ② 4000 A fan-cooled rating is available for 3000 A circuit breakers.
- ③ Because the voltage range factor K = 1, the short-time withstand current and the maximum symmetrical interrupting current are equal to the rated symmetrical interrupting current.
- ④ Based on the standard dc time constant of 45 ms (corresponding to X/R of 17 for 60 Hz) and the minimum contact parting time as determined from the minimum opening time plus the assumed minimum relay time of 1/2 cycle (8.33 ms for 60 Hz).
- ⑤ The asymmetrical interrupting current, I_t total, is given by (I_t) = I x Sqrt (1 + 2 x %dc x %dc) kA rms asymmetrical total.
- ⑥ Duration of short-time current and maximum permissible tripping delay are both 2 seconds for all circuit breakers listed in this table, as required in C37.04-1999, C37.06-2000 and C37.06-2009.
- ⑦ RRRV can also be calculated as = 1.137 x E₂/T₂.
- ⑧ These circuit breakers were tested to the preferred TRV ratings specified in C37.06-2000.

Table 5.3-5. Available VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards (Rated K = 1.0) (Continued)

Identification	Rated Values												
	Continuous Current	Operating Duty	Mechanical Endurance	Capacitance Current Switching Capability (Reference C37.04a-2003, C37.06-2009 and C37.09a-2005)								Out-of-Phase Switching	
				Cable-Charging Current		Isolated Shunt Capacitor Bank Current		Back-to-Back Capacitor Switching				Voltage = 1.44 x V	Current = 0.25 x I
Units	A rms	Duty Cycle	No-Load Operations ①②	Class	A rms	Class	A rms	Class	A rms	kA Peak	kHz		
50VCP-W 25	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	3–10	C2	75–630 75–1000 75–1600	C2	75–630 75–1000 75–1600	6	0.8 0.5 0.3	7	6.3
50VCP-W 40	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	3–10	C2	75–630 75–1000 75–1600	C2	75–630 75–1000 75–1600	6	0.8 0.5 0.3	7	10
50VCP-W 50	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	3–10	C2	75–630 75–1000 75–1600	C2	75–630 75–1000 75–1600	6	0.8 0.5 0.3	7	12.5
50VCP-W 63	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	7.5–25	C2	75–630 75–1000 75–1600	C2	75–630 75–1000 75–1600	6	0.8 0.5 0.3	7	15.8
150VCP-W 25	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	7.5–25	C2 C2 C1	75–630 75–1000 75–1600	C2 C2 C1	75–630 75–1000 75–1600	6	0.8 0.5 0.3	22	6.3
150VCP-W 40	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	7.5–25	C2 C2 C1	75–630 75–1000 75–1600	C2 C2 C1	75–630 75–1000 75–1600	6	0.8 0.5 0.3	22	10
150VCP-W 50	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	7.5–25	C2 C2 C1	75–630 75–1000 75–1600	C2 C2 C1	75–630 75–1000 75–1600	6	0.8 0.5 0.3	22	12.5
150VCP-W 63	1200 2000 3000	O–0.3s–CO–3m–CO	10,000	C2	7.5–25	C2	75–630 75–1000 75–1600	C2	75–630 75–1000 75–1600	6	0.8 0.5 0.3	22	15.8

① Each operation consists of one closing plus one opening.

② All 40 and 50 kA circuit breakers exceed required 5000 no-load operations; all 63 kA circuit breakers exceed the required 2000 no-load ANSI operations.

Table 5.3-6. Available 5/15 kV VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards (Rated K > 1) ①②③④

Identification		Rated Values											Related Required Capabilities						Asymmetry Factor for VCP-W Breakers	
Circuit Breaker Type	Nominal Voltage Class	Nominal 3-Phase MVA Class	Voltage		Insulation Level		Current		Rated Transient Recovery Voltage			Rated Permissible Tripping Delay	Rated Reclosing Time	Rated Maximum Voltage Divided by K	Current Values					
			Rated Maximum Voltage	Rated Voltage Range Factor	Power Frequency Withstand Voltage (1 min.)	Lightning Impulse Withstand Voltage (1.2 x 50 μs)	Rated Continuous Current at 60 Hz	Rated Short-Circuit Current (at Rated Maximum kV)	Rated Crest Voltage	Rated Time to Crest	Rate of Rise of Recovery Voltage ⑦				Rated Interrupting Time	Maximum Sym. Interrupting Capability	3-Second Short-Time Current Carrying Capability	Closing and Latching Capability (Momentary) ⑧		
kV Class	MVA Class	V kV rms	K ⑤	kV rms	kV Crest	⑥ Amp	I ⑤ kA rms	E2 kV Crest	T2 μS	kV/μS	⑧ Cycles	Y ⑨ Sec.	⑩ ms	V/K kV rms	KI kA rms	KI kA rms	2.7 K Times Rated Short-Circuit Current ⑥	1.6 K Times Rated Short-Circuit Current		⑪ S
50VCP-WND 250	4.16	250	4.76	1.24	19	60	1200	29	8.9	50	0.2	5	2	300	3.85	36	36	97	58	1.2
50VCP-W 250	4.16	250	4.76	1.24	19	60	1200 2000 3000	29	8.9	50	0.2	5	2	300	3.85	36	36	97	58	1.2
50VCP-W 350	4.16	350	4.76	1.19	19	60	1200 2000 3000	41	8.9	50	0.2	5	2	300	4.0	49	49	132	78	1.2
75VCP-W 500	7.2	500	8.25	1.25	36	95	1200 2000 3000	33	15.5	60	0.29	5	2	300	6.6	41	41	111	66	1.2
150VCP-W 500	13.8	500	15	1.30	36	95	1200 2000 3000	18	28	75	0.42	5	2	300	11.5	23	23	62	37	1.2
150VCP-W 750	13.8	750	15	1.30	36	95	1200 2000 3000	28	28	75	0.42	5	2	300	11.5	36	36	97	58	1.2
150VCP-W 1000	13.8	1000	15	1.30	36	95	1200 2000 3000	37	28	75	0.42	5	2	300	11.5	48	48	130	77	1.2

① For capacitor switching, refer to Table 5.3-5 and Table 5.3-7.

② 5 and 15 kV circuit breakers are UL listed.

③ Circuit breakers shown in this table were tested in accordance with IEEE standard C37.09-1979.

④ Contact Eaton for availability of these circuit breakers.

⑤ For three-phase and line-to-line faults, the symmetrical interrupting capability at an operating voltage

$$I_{sc} = \frac{V}{V_o} \text{ (Rated Short-Circuit Current)}$$

But not to exceed KI.

Single line-to-ground fault capability at an operating voltage

$$I_{sc} = 1.15 \frac{V}{V_o} \text{ (Rated Short-Circuit Current)}$$

But not to exceed KI.

The above apply on predominately inductive or resistive three-phase circuits with normal-frequency line-to-line recovery voltage equal to the operating voltage.

⑥ 4000 A forced cooled rating is available for 5/15 kV. 3000 A forced cooled rating is available for 38 kV. Contact Eaton for details.

$$\textcircled{7} \text{ RRRV} = 1.137 \frac{E_2}{T_2}$$

⑧ 3-cycle rating available, refer to Table 5.3-5 and Table 5.3-7.

⑨ Tripping may be delayed beyond the rated permissible tripping delay at lower values of current in accordance with the following formula:

$$T \text{ (seconds)} = Y \left(\frac{\text{(K Times Rated Short-Circuit Current)}}{\text{Short-Circuit Current Through Breaker}} \right)^2$$

The aggregate tripping delay on all operations within any 30-minute period must not exceed the time obtained from the above formula.

⑩ For reclosing service, there is **No derating** necessary for Eaton's VCP-W family of circuit breakers. **R = 100%**. Type VCP-W breaker can perform the O-C-O per ANSI C37.09; O-0.3s-CO-15s-CO per IEC 56; and some VCP-Ws have performed O-0.3s-CO-15s-CO-15s-CO-15s-CO; **all with no derating**. Contact Eaton for special reclosing requirements.

⑪ For higher close and latch ratings, refer to Table 5.3-7.

⑫ Included for reference only.

⑬ Asymmetrical interrupting capability = "S" times symmetrical interrupting capability, both at specified operating voltage.

VCP-W Circuit Breaker Operating Times

The closing time (initiation of close signal to contact make) and opening time (initiation of the trip signal to contact break) are shown in **Table 5.3-7**.

Figure 5.3-3 below shows the sequence of events in the course of circuit interruption, along with applicable VCP-W circuit breaker timings.

Table 5.3-7. Closing Time and Opening Time

Rated Control Voltage	Breaker Rating	Closing Time Milliseconds	Opening Time Milliseconds	
			Standard 5-Cycle Breaker	Optional 3-Cycle Breaker
48V, 125V, 250Vdc	All	45–60	30–45	30–38
120V, 240Vac	All	45–60	—	—
120V or 240Vac capacitor trip	All	—	26–41	26–38
Optional—undervoltage trip release 48V, 125V, 250Vdc	All	—	30–45	30–45

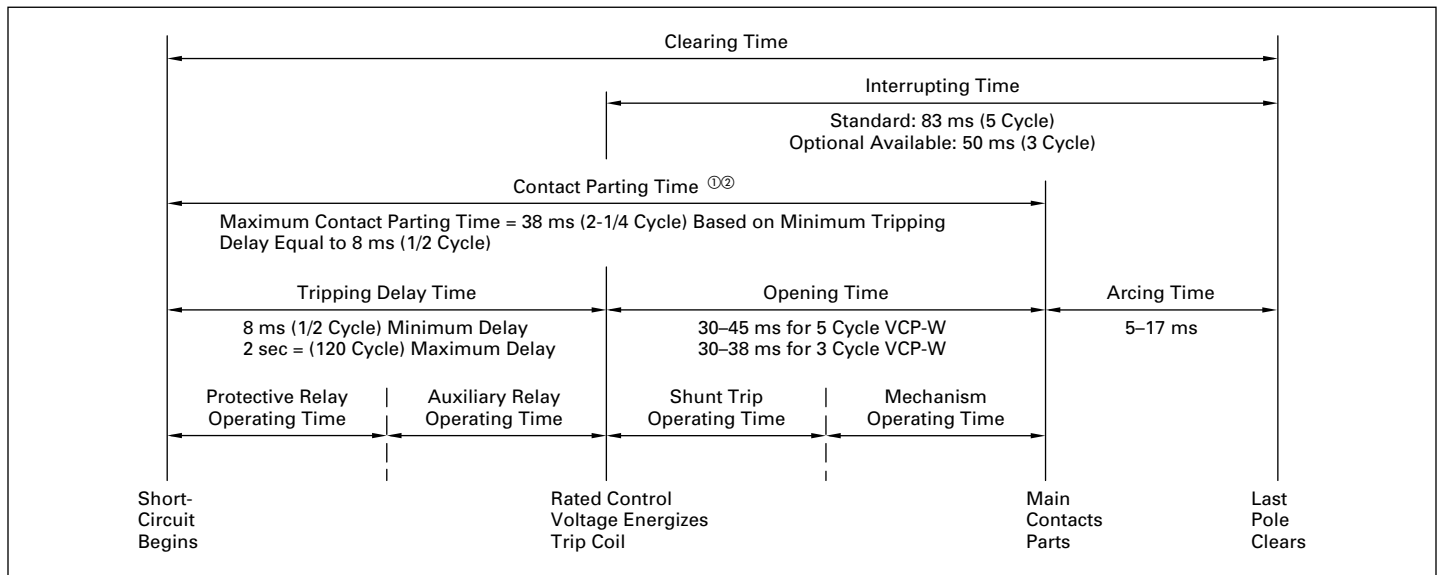


Figure 5.3-3. Sequence of Events and Circuit Breaker Operating Times

- ① Times shown are based on 60 Hz.
- ② % dc component capability (and asymmetry factor S) depend on the minimum contact parting time. The % dc component capability is M 50% (S factor M 1.2) for all VCP-W circuit breakers.

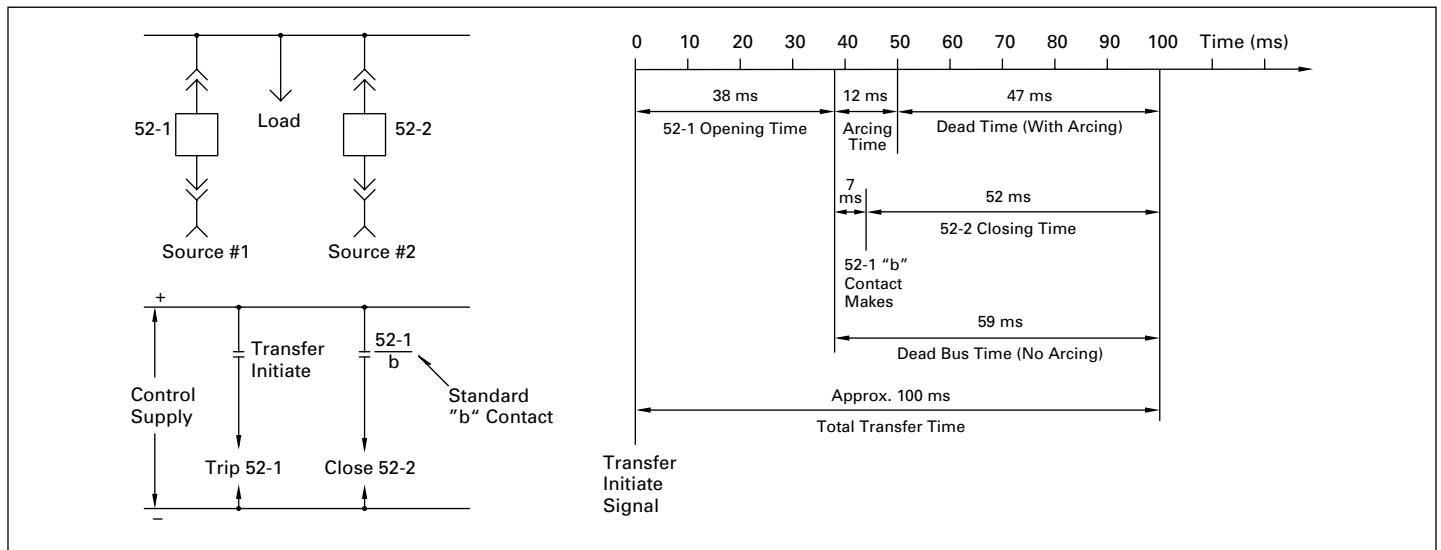


Figure 5.3-4. Typical Transfer Times—Fast Sequential Transfer

- ③ Times shown are based on 60 Hz.

WCP-W Load Current Switching

Table 5.3-8 showing number of operations is a guide to normal maintenance for circuit breakers operated under usual service conditions for most repetitive duty applications including isolated capacitor bank switching and shunt reactor switching, but not for arc furnace switching. The numbers in the table are equal to or in excess of those required by ANSI C37.06.

Maintenance shall consist of adjusting, cleaning, lubricating, tightening, etc., as recommended by the circuit breaker instruction book.

Continuous current switching assumes opening and closing rated continuous current at rated maximum voltage with power factor between 80% leading and 80% lagging.

Inrush current switching ensures a closing current equal to 600% of rated continuous current at rated maximum voltage with power factor of 30% lagging or less, and an opening current equal to rated continuous current at rated maximum voltage with power factor between 80% leading and 80% lagging.

In accordance with ANSI C37.06, if a short-circuit operation occurs before the completion of the listed switching operations, maintenance is recommended and possible functional part replacement may be necessary, depending on previous accumulated duty, fault magnitude and expected future operations.

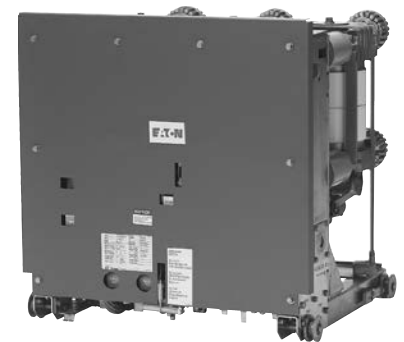
VCP-WC Extra Capabilities Breakers

Introducing the VCP-WC extra capability medium-voltage drawout circuit breaker. Designed to provide all the industry-leading features expected of the VCP-W, plus extra capabilities for those application requirements that go beyond what is usually experienced. The performance enhancement features of the VCP-WC make it an ideal choice for capacitor switching duty, high altitude applications, transformer secondary fault protection, locations with concentrations of rotating machinery or high operating endurance requirements, just to mention a few. Consider these capability enhancements:

- Definite purpose capacitor switching
- Higher close and latch
- Faster rate of rise of recovery voltage
- Higher short-circuit current
- Higher mechanical endurance
- Higher insulation level
- Higher voltage ratings with K=1
- 3-cycle interrupting time
- Higher switching life
- Designed and tested to ANSI standards and higher
- WR fixed retrofit configuration available

Eaton is a world leader in vacuum interrupter and vacuum circuit breaker technology, offering VCP-WC with extra capabilities without sacrificing the proven features already standard with other VCP-W circuit breakers. Features such as:

- Vacuum interrupters with copper-chrome contacts
- V-Flex non-sliding current transfer system
- Visible contact erosion indicators
- Visible contact wipe indicators
- Front, functionally grouped controls and indicators
- Glass-polyester (5/15 kV), or epoxy insulation (27/38 kV)
- Front, vertically mounted stored energy mechanism
- Drawout on extension rails
- Integrally mounted wheels
- Quality Assurance Certificate



The Type VCP-WC Breakers are not Interchangeable with Standard VCP-W Breakers. They are Equipped with Different Code Plates and Taller Front Panels.

Table 5.3-8. Breaker Operations Information

Circuit Breaker Ratings			Maximum Number of Operations ①			
Rated Maximum Voltage kV rms	Rated Continuous Current Amperes	Rated Short-Circuit Current kA rms, sym.	Between Servicing	No-Load Mechanical	Rated Continuous Current Switching	Inrush Current Switching
4.76, 8.25, 15	1200, 2000	33 kA and below	2000	10,000	10,000	750
4.76, 8.25, 15	3000	All	1000	5000	5000	400
4.76, 15	All	37 kA and above	1000	5000	5000	400
27	All	All	500	2500	2500	100
38	All	All	250	1500	1500	100

① Each operation is comprised of one closing plus one opening.

Table 5.3-9. Extra Capability Type VCP-WC Ratings (Symmetrical Current Basis), Rated K = 1

Identification Circuit Breaker Type	Rated Values															Mechanical Endurance No-Load Operations			
	Voltage		Insulation Level		Continuous Current at 60 Hz	Current						Maximum Permissible Tripping Delay	Rate of Rise of Recovery Voltage (RRRV) ^③	Capacitor Switching Ratings					
	Maximum Voltage (V)	Voltage Range Factor	Power Frequency Withstand Voltage (1 min.)	Lightning Impulse Withstand Voltage (1.2 x 50 µs)		Short-Circuit Current								General Purpose	Definite Purpose				
						Sym. Interrupting at Voltage (Isc)	% dc Component (Idc)	Asym. Interrupting (It)	Closing and Latching Capability	Short-Time Current for 3 Seconds ^①	Interrupting Time ^②				Isolated Shunt Capacitor Bank Current		Back-to-Back Capacitor Switching		
	kV rms	K	kV rms	kV Peak	A rms							kA rms Total	%	kA rms			kA Peak	kA rms	ms
50VCP-W 25C	5.95	1	24	75	1200 2000 3000 ^④	25	50 75 75	31 36 36	97	25	50	2.0	0.9 0.9 0.8	400 & 630 1000 250	400 & 630 1000 —	20 & 20 18 —	6.5 & 5.5 2.7 —	10,000 10,000 5,000	
50VCP-W 40C	5.95	1	24	75	1200 2000 3000 ^④	40	75	58	139	40	50	2.0	0.9 0.9 0.8	630 1000 250	630 1000 —	15 18 —	3.5 2.7 —	10,000 10,000 5,000	
50VCP-W 50C	5.95	1	24	75	1200 2000 3000 ^④	50	57 57 52	64 64 62	139	50	50	2.0	0.9 0.9 0.8	630 1000 250	630 1000 —	15 18 —	3.5 2.7 —	10,000 10,000 5,000	
50VCP-W 63C	5.95	1	24	75	1200 2000 3000 ^④	63	62	83	175	63	50	2.0	1.1	250	400 & 1600 ^⑤ 400 & 1600 ^⑤ 400 & 1600 ^⑤	8.8 & 7.7 8.8 & 7.7 8.8 & 7.7	1.6 & 0.465 1.6 & 0.465 1.6 & 0.465	10,000 10,000 10,000	
75VCP-W 50C	10.3	1	42	95	1200 2000 3000 ^④	50	57 57 52	64 64 62	139	50	50	2.0	0.9 0.9 0.8	630 1000 250	630 1000 —	15 18 —	3.5 2.7 —	10,000 10,000 5,000	
150VCP-W 25C	17.5	1	42	95	1200 2000 3000 ^④	25	50 75 75	31 36 36	97 ^⑥	25	50	2.0	0.9 0.9 0.8	400 & 600 ^⑦ 1000 ^⑦ 250 ^⑦	400 & 600 ^⑦ 1000 ^⑦ —	20 & 20 18 —	6.5 & 5.5 2.7 —	10,000 10,000 5,000	
150VCP-W 40C	17.5	1	42	95	1200 2000 3000 ^④	40	75	58	139	40	50	2.0	0.9 0.9 0.8	630 ^⑦ 1000 ^⑦ 250 ^⑦	630 ^⑦ 1000 ^⑦ —	15 18 —	3.5 2.7 —	10,000 10,000 5,000	
150VCP-W 50C	17.5	1	42	95	1200 2000 3000 ^④	50	57 57 52	64 64 62	139	50	50	2.0	0.9 0.9 0.8	630 ^⑦ 1000 ^⑦ 250 ^⑦	630 ^⑦ 1000 ^⑦ —	15 18 —	3.5 2.7 —	10,000 10,000 5,000	
150VCP-W 63C	15	1	42	95	1200 2000 3000 ^④	63	62	83	175	63	50	2.0	1.1	250	400 & 1600 ^⑤ 400 & 1600 ^⑤ 400 & 1600 ^⑤	8.8 & 7.7 8.8 & 7.7 8.8 & 7.7	1.6 & 0.465 1.6 & 0.465 1.6 & 0.465	10,000 10,000 10,000	

① Except as noted.

② 3 cycles.

③ Contact Eaton for higher RRRV or for more information.

④ 4000 A FC rating available.

⑤ C37.04.a-2003 Class C2 at 15 kV.

⑥ Close and Latch Current for 1200 A Type 150VCP-W 25C is proven at 15 kV. For sealed interrupters at high altitudes, switching voltage is not derated.

⑦ Capacitor Switching Ratings are proven at 15 kV. For sealed interrupters at high altitudes, switching voltage is not derated.

⑧ 2.5 seconds.

⑨ 1.6 second.

⑩ 1 second.

⑪ 2000 A FC to 3000 A.

⑫ 2500 A FC to 3000 A.

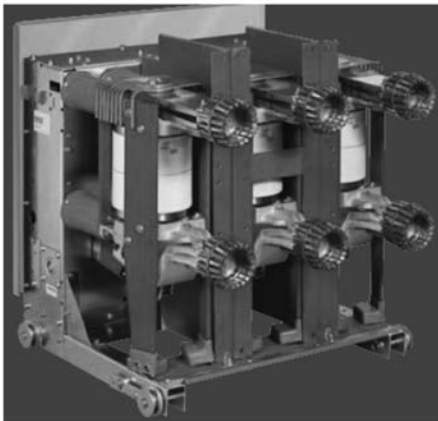
⑬ Tested at 27 kV, 350 A isolated or back-to-back capacitor bank, inrush current 4.6 kA, inrush frequency 1.2 kHz.

Note: 38 kV, 2500 A and 3000 AWC breakers are not rated for rapid reclosing.

Type VCP-WG Generator Circuit Breakers



VCP-WG Breaker (Front View)



VCP-WG Breaker (Rear View)

Why generator circuit breakers?

- Specially rated generator breakers typically should be used on generator applications 10,000 kW and above
- A generator circuit breaker, properly rated and tested to the appropriate industry standard, can protect the generator from damage, or even complete failure, that could occur when feeding a faulted transformer, and also can protect the transformer, in the event that a fault should occur in the generator

Generator circuits have unique characteristics that require specially designed and tested circuit breakers. The IEEE developed the special industry standard C37.013 and amendment C37.013a-2007 to address these characteristics. Eaton has dedicated years of research, design, enhancement and testing to create Eaton's family of generator breakers.

The VCP-WG (drawout) and VCP-WRG (fixed) circuit breakers meet, and even exceed, the rigorous service duty requirements for generator circuit applications as defined by IEEE.

Eaton's VCP-WG and VCP-WRG generator breakers are available in two frame sizes. The 29.00-inch frame (29.00 inches wide with front cover on) has ratings up to 15 kV, 63 kA and 3000 A (4000 A with forced-air cooling). The 31.00-inch frame (31.00 inches wide with front cover on) has ratings up to 15 kV, 75 kA and 4000 A (5000 A with forced-air cooling). The 31.00-inch frame is also available in a fixed version with ratings up to 15 kV, 75 kA and 6000 A (7000 A with forced-air cooling).

Count on Eaton's innovative technology to handle high continuous ac current and voltage, then safely switch through extreme out-of-phase voltages and high-stress asymmetrical currents using "clean and green" vacuum interruption without fail for over 10,000 normal operations.

Eaton's VCP-WG generator circuit breakers meet the strict service duty requirements set forth by IEEE for generator circuit applications, including:

- Generator circuit configuration
- High continuous current levels
- Unique fault current conditions
 - Transformer-fed faults
 - Generator-fed faults
- Unique voltage conditions
 - Very fast RRRV
 - Out-of-phase switching

Generator Circuit Configuration

The transformer and generator can be in close proximity to the circuit breaker. See **Figure 5.3-5**. Applications with high continuous current levels require connections with large conductors of very low impedance. This construction causes unique fault current and voltage conditions as shown in **Figure 5.3-6**.

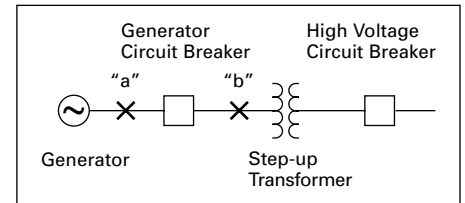


Figure 5.3-5. Generator Circuit Application

High Continuous Current Levels

Generator circuit breakers must be able to handle high continuous current levels without overheating. VCP-WG drawout circuit breakers are designed to reliably operate up to 4000 A with natural air convection cooling, and up to 5000 A with suitable enclosure fan cooling during overload conditions. VCP-WRG fixed circuit breakers are designed to reliably operate up to 6000 A with natural air convection cooling and up to 7000 A with suitable enclosure fan cooling during overload conditions.

Unique Fault Current Conditions

System-source (aka, transformer-fed) faults (see **Figure 5.3-5**, fault location “a”) can be extremely high. The full energy of the power system feeds the fault, and the low impedance of the fault current path does very little to limit the fault current. Eaton’s type VCP-WG Generator Circuit Breakers are ideal for interrupting such high fault currents because they have demonstrated high interruption ratings up to 75 kA, with high dc fault content up to 75%, as proven by high power laboratory tests.

Generator-source (aka, generator-fed) faults, see **Figure 5.3-5**, fault location “b”) can cause a severe condition called “Delayed Current Zero,” see **Figure 5.3-6**).

The high ratio of inductive reactance to resistance (X/R ratio) of the system can cause the dc component of the fault current to exceed 100%. The asymmetrical fault current peak becomes high enough and its decay becomes slow enough that the natural current zero is delayed for several cycles. The circuit breaker experiences longer arcing time and more electrical, thermal and mechanical stress during the interruption.

The IEEE standard requires verification that the circuit breaker can interrupt under these severe conditions. Eaton’s VCP-WG generator circuit breakers have demonstrated their ability to interrupt three-phase fault current levels up to 135% dc content under delayed current zero conditions.

Table 5.3-10. Breaker Operations Information

Circuit Breaker Ratings			Maximum Number of Operations ①			
Rated Maximum Voltage kV rms	Rated Continuous Current Amperes	Rated Short-Circuit Current kA rms, sym.	Between Servicing	No-Load Mechanical	Rated Continuous Current Switching	Inrush Current Switching
4.76, 8.25, 15	1200, 2000	33 kA and below	2000	10,000	10,000	750
4.76, 8.25, 15	3000	All	1000	5000	5000	400
4.76, 15	All	37 kA and above	1000	5000	5000	400
27	All	All	500	2500	2500	100
38	All	All	250	1500	1500	100

① Each operation is comprised of one closing plus one opening.

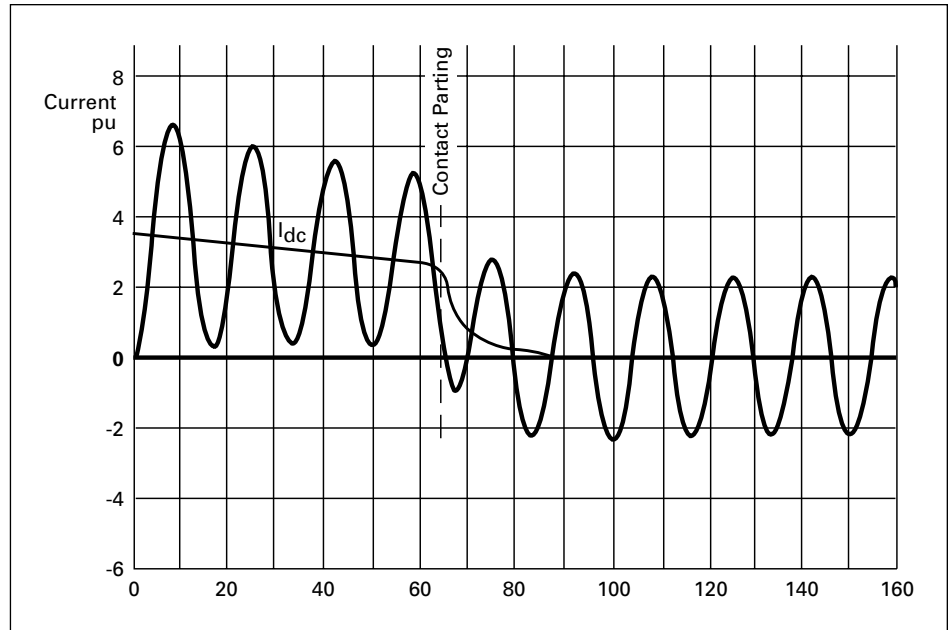


Figure 5.3-6. Generator-Fed Faults Can Experience Delayed Current Zero, Where the High Inductance to Resistance Ratio of the System Can Cause the dc Component of the Fault Current to Exceed 100%

Unique Voltage Conditions

Generator circuits typically produce very fast rates of rise of recovery voltage (RRRV) due to the high natural frequency and low impedance and very low stray capacitance. VCP-WG generator circuit breakers are designed to interrupt fault current levels with very fast RRRV in accordance with IEEE standard C37.013 and C37.013a. VCP-WG generator circuit breakers have a distinct ability to perform under out-of-phase conditions when the generator and power system voltages are not in sync. The voltages across the open contacts can be as high as twice the rated line-to-ground voltage of the system. The IEEE standard requires demonstration by test that the generator circuit breaker can switch under specified out-of-phase conditions.

Versatility in Application

Eaton's generator vacuum circuit breakers are available in drawout (VCP-WG) or fixed (VCP-WRG) configurations to provide for superior performance and versatility. Many industrial and commercial power systems now include small generators as a local source of power. New applications are arising as a result of the de-regulation of the utility industry, and the construction of smaller packaged power plants. Eaton's generator breakers interrupt large short-circuit currents in a small three-pole package.

Typical applications include:

- Electric utilities: fossil, hydro and wind power
- Packaged power plants
- Industrial companies using combined cycle/combustion turbine plants
- Government and military
- Commercial institutions
- Petrochemical and process industries
- Forestry, pulp and paper
- Mining, exploration and marine

The VCP-WG is the world's generator circuit breaker for reliable and robust power generation protection.

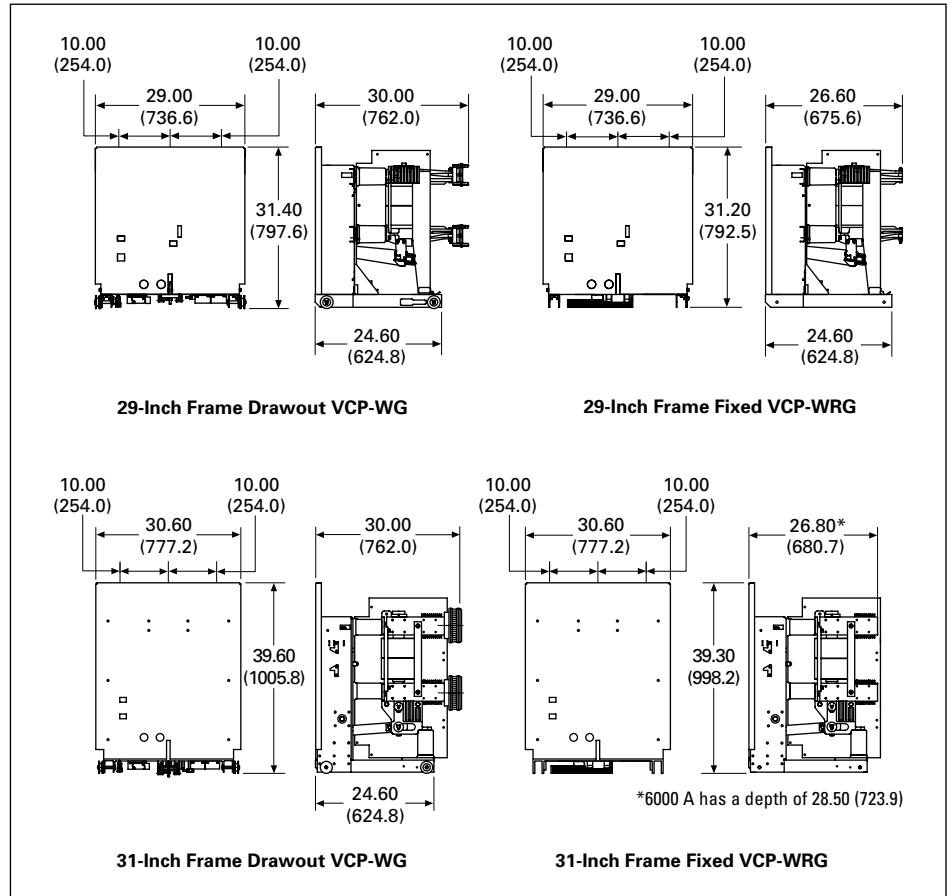


Figure 5.3-7. Type VCP-WG (Drawout) and Type VCP-WRG (Fixed) Circuit Breakers

5 kV Class Generator Circuit Breaker Ratings

Table 5.3-11. Generator Circuit Breaker Types: VCP-WG (Drawout—DO) / VCP-WRG (Fixed—FIX)

Description	Units	Short-Circuit Current (Isc)									
		50 kA		63 kA		75 kA		75 kA		75 kA	
Maximum Voltage (V): 5 kV											
Frame in Inches (mm) (see Figure 5.3-7 on Page 5.1-17)	—	29.00 (736.6)	29.00 (736.6)	31.00 (787.4)	31.00 (787.4)	29.00 (736.6)	29.00 (736.6)	31.00 (787.4)	31.00 (787.4)	31.00 (787.4)	31.00 (787.4)
Ratings Assigned	—	DO	FIX	DO	FIX	DO	FIX	DO	FIX	DO	FIX
Continuous Current	A rms	1200	1200	—	—	1200	1200	—	—	1200	1200
		2000	2000	—	—	2000	2000	—	—	2000	2000
		3000	3000	—	—	3000	3000	—	—	3000	3000
		4000 ^①	4000 ^①	4000	4000	4000 ^①	4000 ^①	4000	4000	4000	4000
		—	—	5000 ^①	5000	—	—	5000 ^①	5000	5000 ^①	5000
		—	—	—	6000	—	—	—	6000	—	6000
		—	—	—	6300 ^①	—	—	—	6300 ^①	—	6300 ^①
		—	—	—	7000 ^①	—	—	—	7000 ^①	—	7000 ^①
Dielectric Strength											
Power frequency withstand voltage	kV rms	19	19	19	19	19	19	19	19	19	19
Lightning impulse withstand voltage	kV peak	60	60	60	60	60	60	60	60	60	60
Interrupting Time	ms	50	50	83	83	50	50	83	83	83	83
Closing Time	ms	47	47	47	47	47	47	47	47	47	47
Short-Circuit Current	kA rms	50	50	50	50	63	63	63	63	75	75
Asymmetrical current interrupting capability	% dc	75	75	75	75	75	75	75	75	63	63
Ref: Minimum opening time	ms	30	30	54	54	30	30	54	54	54	54
Short-time current carrying capability	kA rms	50	50	50	50	63	63	63	63	75	75
Duration of short-time current	sec	3	3	2.3	2.3	3	3	1.4	1.4	1	1
Closing and Latching Capability	kA peak	137	137	137	137	173	173	173	173	206	206
First Generator-Source Symmetrical Current Interrupting Capability	kA rms	25	25	25	25	31.5	31.5	31.5	31.5	40	40
First Generator-Source Asymmetrical Current Interrupting Capability	% dc	130	130	130	130	130	130	130	130	130	130
Second Generator-Source Symmetrical Current Interrupting Capability	kA rms	—	—	31.5	31.5	40	40	40	40	50	50
Second Generator-Source Asymmetrical Current Interrupting Capability	% dc	—	—	110	110	110	110	110	110	110	110
Prospective TRV—Rate of Rise of Recovery Voltage (RRRV)	kV / μ s	3.0	3.0	3.0 ^②	3.0 ^②	3.0	3.0	3.0 ^②	3.0 ^②	3.0 ^②	3.0 ^②
Transient recovery voltage—Peak (E2 = 1.84 x V)	kV peak	9.2	9.2	9.2 ^②	9.2 ^②	9.2	9.2	9.2 ^②	9.2 ^②	9.2 ^②	9.2 ^②
Transient recovery voltage—Time to Peak (T2 = 0.62 x V)	μ s	3.1	3.1	3.1 ^②	3.1 ^②	3.1	3.1	3.1 ^②	3.1 ^②	3.1 ^②	3.1 ^②
Load Current Switching Endurance Capability	Operations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
No-Load Mechanical Endurance Capability	Operations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Out-of-Phase Current Switching Capability	kA	25	25	25	25	31.5	31.5	31.5	31.5	37.5	37.5
90° out-of-phase power frequency recovery voltage (= 1.5 x sqrt(2/3) x V)	kV rms	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
90° out-of-phase inherent TRV—Rate of Rise of Recovery Voltage (RRRV)	kV / μ s	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Transient recovery voltage—Peak (E2 = 2.6 x V)	kV peak	13	13	13	13	13	13	13	13	13	13
Transient recovery voltage—Time to Peak (T2 = 0.89 x V)	μ s	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5

① Ratings achieved using forced-air cooling by blowers in the enclosure.

② TRV capacitors are required if RRRV is >0.5 kV/ μ s; or T2 is <65 μ s.

Note: Rated frequency: 60 Hz.

Note: Standard operating duty: CO - 30 m - CO.

Note: Relevant Standard: IEEE standards C37.013-1997 and C37.013a-2007.

Note: Test certificates available.

15 kV Class Generator Circuit Breaker Ratings

Table 5.3-11. Generator Circuit Breaker Types: VCP-WG (Drawout—DO) / VCP-WRG (Fixed—FIX) (Continued)

Description	Units	Short-Circuit Current (Isc)									
		50 kA		63 kA		75 kA		31.00 (787.4)		31.00 (787.4)	
Maximum Voltage (V): 15 kV											
Frame in Inches (mm) (see Figure 5.3-7 on Page 5.1-17)	—	29.00 (736.6)	29.00 (736.6)	31.00 (787.4)	31.00 (787.4)	29.00 (736.6)	29.00 (736.6)	31.00 (787.4)	31.00 (787.4)	31.00 (787.4)	31.00 (787.4)
Ratings Assigned	—	DO	FIX	DO	FIX	DO	FIX	DO	FIX	DO	FIX
Continuous Current	A rms	1200	1200	—	—	1200	1200	—	—	1200	1200
		2000	2000	—	—	2000	2000	—	—	2000	2000
		3000	3000	—	—	3000	3000	—	—	3000	3000
		4000 ①	4000 ①	4000	4000	4000 ①	4000 ①	4000	4000	4000	4000
		—	—	5000 ①	5000	—	—	5000 ①	5000	5000 ①	5000
		—	—	—	6000	—	—	—	6000	—	6000
		—	—	—	6300 ①	—	—	—	6300 ①	—	6300 ①
		—	—	—	7000 ①	—	—	—	7000 ①	—	7000 ①
Dielectric Strength											
Power frequency withstand voltage	kV rms	36	36	36	36	36	36	36	36	36	36
Lightning impulse withstand voltage	kV peak	95	95	95	95	95	95	95	95	95	95
Interrupting Time	ms	50	50	83	83	50	50	83	83	83	83
Closing Time	ms	47	47	47	47	47	47	47	47	47	47
Short-Circuit Current	kA rms	50	50	50	50	63	63	63	63	75	75
Asymmetrical current interrupting capability	% dc	75	75	75	75	75	75	75	75	63	63
Ref: Minimum opening time	ms	30	30	54	54	30	30	54	54	54	54
Short-time current carrying capability	kA rms	50	50	50	50	63	63	63	63	75	75
Duration of short-time current	s	3	3	2.3	2.3	3	3	1.4	1.4	1	1
Closing and Latching Capability	kA peak	137	137	137	137	173	173	173	173	206	206
First Generator-Source Symmetrical Current Interrupting Capability	kA rms	25	25	25	25	31.5	31.5	31.5	31.5	40	40
First Generator-Source Asymmetrical Current Interrupting Capability	% dc	130	130	130	130	130	130	130	130	130	130
Second Generator-Source Symmetrical Current Interrupting Capability	kA rms	—	—	31.5	31.5	40	40	40	40	50	50
Second Generator-Source Asymmetrical Current Interrupting Capability	% dc	—	—	110	110	110	110	110	110	110	110
Prospective TRV—Rate of Rise of Recovery Voltage (RRRV)	kV / μ s	3.4	3.4	3.4 ②	3.4 ②	3.4	3.4	3.4 ②	3.4 ②	3.4 ②	3.4 ②
Ref: Minimum opening time	kV peak	27.6	27.6	27.6 ②	27.6 ②	27.6	27.6	27.6 ②	27.6 ②	30.9 ②	30.9 ②
Transient recovery voltage—Peak (E2 = 1.84 x V)											
Transient recovery voltage—Time to Peak (T2 = 0.62 x V)	μ s	9.3	9.3	9.3 ②	9.3 ②	9.3	9.3	9.3 ②	9.3 ②	9.3 ②	9.3 ②
Load Current Switching Endurance Capability	Operations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
No-Load Mechanical Endurance Capability	Operations	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Out-of-Phase Current Switching Capability	kA	25	25	25	25	31.5	31.5	31.5	31.5	37.5	37.5
90° out-of-phase power frequency recovery voltage (= 1.5 x sqrt(2/3) x V)	kV rms	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4	18.4
90° out-of-phase inherent TRV—Rate of Rise of Recovery Voltage (RRRV)	kV / μ s	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Transient recovery voltage—Peak (E2 = 2.6 x V)	kV peak	39	39	39	39	39	39	39	39	39	39
Transient recovery voltage—Time to Peak (T2 = 0.89 x V)	μ s	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4

① Ratings achieved using forced-air cooling by blowers in the enclosure.

② TRV capacitors are required if RRRV is >0.5 kV/ μ s; or T2 is <65 μ s.

Note: Rated frequency: 60 Hz.

Note: Standard operating duty: CO - 30 m - CO.

Note: Relevant Standard: IEEE standards C37.013-1997 and C37.013a-2007.

Note: Test certificates available.

Switchgear Meters



Switchgear Meters

Eaton's Power Xpert™ Power and Energy Meters, and Power Xpert Dashboard products allow switchgear owners and operators to interface with their equipment at varying levels of sophistication. To learn more about these devices, visit our web or click on links above.

Protective Relays



Protective Relays

Eaton can provide a wide range of protective relays to meet you most complex protection and system needs.

Instrument Transformers

Instrument transformers are used to protect personnel and secondary devices from high voltage, and permit use of reasonable insulation levels for relays, meters and instruments. The secondaries of standard instrument transformers are rated at 5 A and/or 120 V, 60 Hz.

Voltage Transformers

Selection of the ratio for voltage transformers is seldom a question since the primary rating should be equal to or higher than the system line-to-line voltage. The number of potential transformers per set and their connection is determined by the type of system and the relaying and metering required.

When two VTs are used, they are typically connected L-L, and provide phase-to-phase voltages, (Vab, Vbc, Vca) for metering and relaying.

When three VTs are used, they are connected line-to-ground, and provide phase-to-phase (Vab, Vbc, Vca), as well as phase-to-ground (Va, Vb, Vc) voltages for metering and relaying.

If metering or relaying application requires phase-to-ground voltages, use three VTs, each connected L-G. If not, use of two VTs connected L-L is sufficient.

For ground detection, three VTs connected in Line-to-ground/ broken-delta are used.

A single VT, when used, can be connected line-to-line (it will provide line-to-line output, for example Vab or Vbc or Vca), or line-to-ground (it will provide line-to-ground output, for example Va or Vb or Vc). Generally, a single VT is used to derive voltage signal for synchronizing or Over Voltage/Under Voltage function.

Current Transformers

The current transformer ratio is generally selected so that the maximum load current will read about 70% full scale on a standard 5 A coil ammeter. Therefore, the current transformer primary rating should be 140–150% of the maximum load current.

Maximum system fault current can sometimes influence the current transformer ratio selection because the connected secondary devices have published one-second ratings.

The zero-sequence current transformer is used for sensitive ground fault relaying or self-balancing primary current type machine differential protection. The zero-sequence current transformer is available with a nominal ratio of 50/5 or 100/5 and available opening size for power cables of 7.25 inches (184.2 mm). Special zero-sequence transformers with larger windows are also available.

The minimum number of current transformers for circuit relaying and instruments is three current transformers, one for each phase or two-phase connected current transformers and one zero-sequence current transformer. Separate sets of current transformers are required for differential relays.

The minimum pickup of a ground relay in the residual of three-phase connected current transformers is primarily determined by the current transformer ratio. The relay pickup can be reduced by adding one residual connected auxiliary current transformer. This connection is very desirable on main incoming and tie circuits of low resistance grounded circuits.

Standard accuracy current transformers are normally more than adequate for most standard applications of microprocessor-based protective relays and meters. See **Table 5.3-14** for CT accuracy information.

Table 5.3-12. Standard Voltage Transformer Ratio Information

Rating-Volts	2400	4200	4800	7200	8400	10800	12000	14400
Ratio	20-1	35-1	40-1	60-1	70-1	90-1	100-1	120-1

Table 5.3-13. Standard Voltage Transformer, 60 Hz Accuracy Information

Switchgear		Voltage Transformer – ANSI Accuracy										Thermal Rating 55 °C Connection	Volt-Ampere
kV Class	kV BIL	Maximum Number Per Set and Connection	Standard Ratios	Burdens at 120 Volts				Burdens at 69.3 Volts					
				W, X, Y	Z	M	ZZ	W, X	Y	M	Z		
5	60	2LL or 3LG	20, ① 35, 40	0.3	1.2	–	–	0.3	–	–	–	LL LG LG ②	700 400 700
7.5 and 15	95	2LL or 3LG	35, 40, 60, 70, 100, 120	0.3	0.3	0.3	0.6	0.3	0.3	0.3	1.2	LL LG LG ②	1000 550 1000

① For solidly grounded 4160V system only or any type 2400V system.

② For solidly grounded system only.

Note: LL = Line-to-line connection. LG = Line-to-ground connection.

Table 5.3-14. Current Transformers, 55 °C Ambient

CT Ratio (MR = Multi-Ratio)	Metering Accuracy Classification			Relaying Accuracy Classification		
	At 60 Hz Standard Burden B 0.1	At 60 Hz Standard Burden B 0.5	At 60 Hz Standard Burden B 1.8	Minimum Accuracy Required per IEEE C37.20.2	Standard Accuracy Supplied in VCP-W Switchgear	Optional High Accuracy Available in VCP-W Switchgear
50:5	1.2	–	–	C10	–	C10
75:5	1.2	2.4	–	C10	C10	C20
100:5	1.2	2.4	–	C10	C10	C20
150:5	0.6	2.4	–	C20	C20	C50
200:5	0.6	2.4	–	C20	C20	C50
250:5	0.6	2.4	–	③	C20	C50
300:5	0.6	2.4	2.4	C20	C20	C100
400:5	0.3	1.2	2.4	C50	C50	C100
500:5	0.3	0.3	2.4	③	C50	C100
600:5	0.3	0.3	2.4	C50	C100	C200
800:5	0.3	0.3	1.2	C50	C100	C200
1000:5	0.3	0.3	0.3	③	C100	C200
1200:5	0.3	0.3	0.3	C100	C200	C400
1500:5	0.3	0.3	0.3	C100	C200	C400
2000:5	0.3	0.3	0.3	C100	C200	C400
2500:5	0.3	0.3	0.3	③	C200	C400
3000:5	0.3	0.3	0.3	C100	C200	C400
4000:5	0.3	0.3	0.3	C100	C200	C400
600:5 MR	0.3	0.3	2.4	③	C100	C200
1200:5 MR	0.3	0.3	0.3	③	C200	C400
2000:5 MR	0.3	0.3	0.3	③	C200	C400
3000:5 MR	0.3	0.3	0.3	③	C200	C400
50:5 zero sequence	–	–	–	–	C10	–
100:5 zero sequence	–	–	–	–	C20	–

③ Not listed in C37.20.2.

Note: Maximum number of CTs— Two sets of standard accuracy or one set of high accuracy CTs can be installed in the breaker compartment on each side of the circuit breaker.

Dummy Element (Dummy Breaker)

Dummy element is a drawout element with primary disconnects similar to a drawout circuit breaker, but consists of solid copper conductors in place of vacuum interrupters, and is designed for manual racking. It is typically used as drawout disconnect link in the primary system for circuit isolation or bypass.

The device is insulated to suit the voltage rating of the switchgear and will carry required levels of short-circuit current, but it is not rated for any current interruption. It must be key interlocked with all source devices such that it can only be inserted into or removed from its connected position only after the primary circuit in which it is to be applied is completely de-energized.

Before using a dummy element, it is recommended that each user develop detailed operating procedure consistent with safe operating practices. Only qualified personnel should be authorized to use the dummy element.

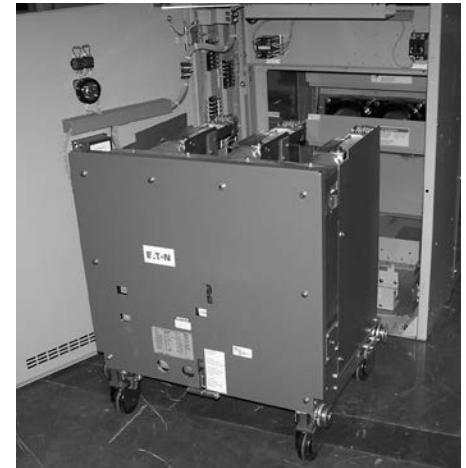
Roll-on-the-Floor Breaker Option



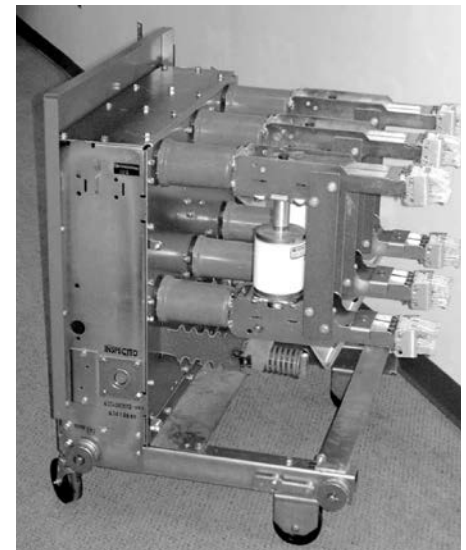
Roll-on-the-Floor Switchgear Compartment

An optional direct roll-in breaker designed for use in upper and lower compartment of 5/15 kV indoor and outdoor walk-in aisle switchgear is available for all 5/15 kV VCP-W, VCP-WC and VCP-WG circuit breakers. Breaker is fitted with special wheel kit, and compartment interface is modified to allow circuit breaker to be rolled directly from the floor into the switchgear compartment, or from switchgear compartment onto the floor without a need for external lifting device or dolly. The circuit breaker can be supplied with all four fixed wheels or can be supplied with two swivel-type wheels on the front and two fixed wheels on the rear. In 2-high construction, the roll-on-the-floor breaker option is available for breakers in upper or lower compartments, however, removal of upper breaker requires external lifter and lift pan, which are optional accessories.

When using a 1200 or 2000 A circuit breaker in the lower compartment, the compartment above the breaker can be left blank or used of auxiliaries, such as VTs or single-phase CPT, or primary fuses for three-phase or larger than 15 kVA single-phase CPTs. When using 3000 A circuit breaker in the lower compartment, the compartment above the breaker is left blank for ventilation. The design is rated for application in IBC/CBC seismic environment. It can also be supplied with UL or CSA label for certain ratings. Contact Eaton for ratings available with UL/CSA label. The overall dimensions of the 5/15 kV indoor and outdoor walk-in aisle structures with the roll-on-the-floor breaker option are the same as the standard structures that use standard non roll-on-the-floor circuit breakers.

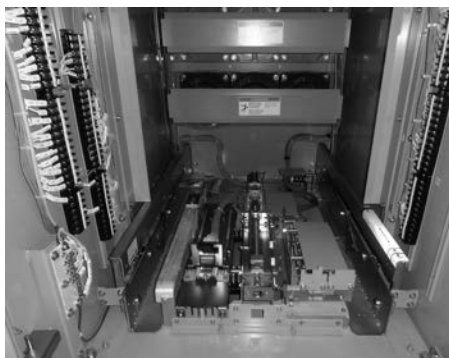


VCP-W Direct Roll-in Breaker with Fixed Wheels

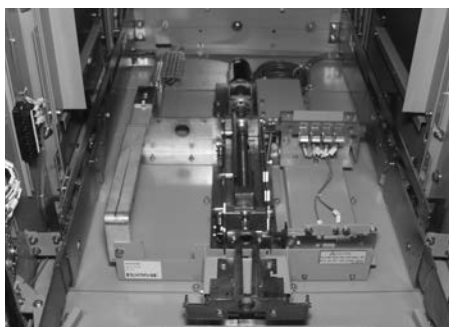


VCP-W Direct Roll-in Breaker with Swivel Wheels on Front

Integral Motorized Remote Racking Option (VC-W MR2)



Breaker Levering Pan Assembly with Test Position – VC-W MR2 Integral Racking Device



Type VC-W Arc-Resistant Switchgear Auxiliary Drawer with Type MR2 Integral Racking



Type VC-W Standard Switchgear Auxiliary Drawer with Type MR2 Integral Racking



MR2 Hand-Held Pendant

VC-W MR2 is an optional motorized racking device accessory installed inside a circuit breaker or auxiliary compartment. It is available for application in circuit breaker compartments of 5/15/27/38 kV Type VC-W arc and non-arc, and 5 kV VC-W ND metal-clad switchgear. It is also available for application in auxiliary compartments of 5/15 kV Type VC-W arc-resistant and standard switchgear. This optional accessory allows a user to safely move a circuit breaker between Connected, Test and Disconnected positions and auxiliary drawer (VT, CPT, primary fuse) between Connected and Disconnected positions within their respective compartments from a safe distance away from the switchgear. The MR2 controller also allows a user to electrically open and close the circuit breaker from a safe distance away from the switchgear. For switchgear designs/ratings not included above, contact Eaton for availability of MR2 accessory.

A microprocessor-based controller card, located below the drive motor, interfaces with an external hand-held pendant (standard), discrete external I/O (optional) or external Modbus communication (optional) and controls the breaker/auxiliary drawer movement via the drive motor. The system is also designed such that it allows manual racking of the breaker/auxiliary using the levering crank accessory if needed. The VC-W MR2 controller interface is shown in **Figure 5.3-8**. The crank safety switch disables the motor whenever a breaker/auxiliary is being manually racked in or out. The connect, test and disconnect limit switches provide breaker/auxiliary position inputs to the controller card. In addition to the standard permissive switch, two terminals are provided for connection of the customer's external interlocking/permissive contact(s). Note that a single-phase 120 Vac control supply is required for proper operation of the VC-W MR2 controller and the drive motor.

When VC-W MR2 integral racking is supplied, its controller card is wired to the CAT 6 jack installed in the associated breaker/auxiliary compartment door, and each switchgear lineup is shipped with one hand-held pendant with 30 feet of CAT 6 cable (lengths up to 100 ft available). The pendant interfaces with the MR2 controller card via the CAT 6 cable through a CAT 6 jack located on the breaker/auxiliary compartment door. It allows the operator to move away from the switchgear up to 30 feet. The pendant includes Enable pushbutton for additional security. It must be pressed in order to activate the pendant functions. By pressing Enable pushbutton and an appropriate function pushbutton together momentarily, the operator can rack the breaker between Connected, Test and Disconnected positions or open or close the breaker or rack the auxiliary drawer between Connected and Disconnected positions. Breaker or auxiliary drawer positions (Connect, Test, Disconnect) and breaker opened/closed status are indicated by appropriate LED lights on the pendant. A blinking light indicates that the breaker/auxiliary is in motion through the selected position.

A solid (non-blinking) light indicates that the breaker/auxiliary has reached and stopped in the selected position. In case normal operation fails, the appropriate error code is displayed in a separate two-character LED display window on the pendant. A list of various error codes and their descriptions along with suggested corrective actions are printed on the back side of the pendant. Examples of error states: motor overcurrent, motor overtemperature, motor timed out, breaker position unknown, open permissive, communication error and no breaker/auxiliary.

In addition to pendant, three optional I/O interfaces can be supplied as follows:

1. I/O interface to allow racking of breaker (connect, test, disconnect) or auxiliary drawer (connect, disconnect) by external hardwired dry contacts and 24 Vdc output for corresponding remote position indicating LEDs.
2. I/O board that provided dry contacts for remote indication of breaker (connect, intermediate, test, disconnect)/auxiliary drawer (connect, test) position within its compartment.
3. I/O interface to allow breaker open/close functions via external hardwired dry contacts and 24 Vdc output for corresponding remote open/close status LEDs.

The remote LED lights are not included with MR2. If the customer needs to operate the MR2 with the hand-held pendant, the pendant becomes the master and will override the customer's remote control signals.

The VC-W MR2 controller is also equipped with terminal blocks to allow the customer to interface with the controller via their SCADA system using a Modbus interface. Please note that only one of the two options, discrete I/O interface or Modbus interface, can be used, but not both.

Figure 5.3-9 shows an illustration of a typical Modbus control example. Additional components shown outside the MR2 controller in **Figure 5.3-9** are not included with the MR2. System-level controls can be optionally supplied by Eaton's Engineering Services & Systems. If the customer needs to operate the MR2 with the hand-held pendant, the pendant becomes the master and will override the Modbus interface. Error codes are displayed on Modbus devices when controlling the MR2 with Modbus and on the pendant when controlling with the pendant.

Technical Data

Control Supply Ratings

- Nominal control voltage—120 Vac, 50 or 60 Hz, single-phase
- Control voltage range—100 to 140 Vac, 50 or 60 Hz
- Time to travel from connect to disconnect, or disconnect to connect—50 seconds maximum
- Current draw during the travel—15 A maximum for about 3 seconds and 3.6 A for about 24 seconds
- Optional dry output contacts when included for position indications are rated for 125 Vac, 2 A
- External permissive contacts, when used, must be rated for 24 Vdc, 50 mA

Requirements for External Contacts and LEDs when Interfacing with MR2

- External contacts should be rated for minimum open circuit voltage of 24 Vdc, and be able to close and carry 5 mA at 24 Vdc
- When remote LEDs are used, use 24 Vdc rated LEDs, current up to 20 mA
- Optional dry output contacts when included for position indications are rated for 125 Vac, 2 A
- External permissive contacts, when used, must be rated for 24 Vdc, 50 mA

It is the customer's responsibility to provide single-phase 120 V, 50 or 60 Hz nominal supply for the MR2 controller. It can be derived from within the switchgear if an appropriate control power transformer is available within the switchgear.

Type VC-W MR2 motorized racking accessory has been endurance tested and guaranteed for 500 operations as required by IEEE C37.20.2.

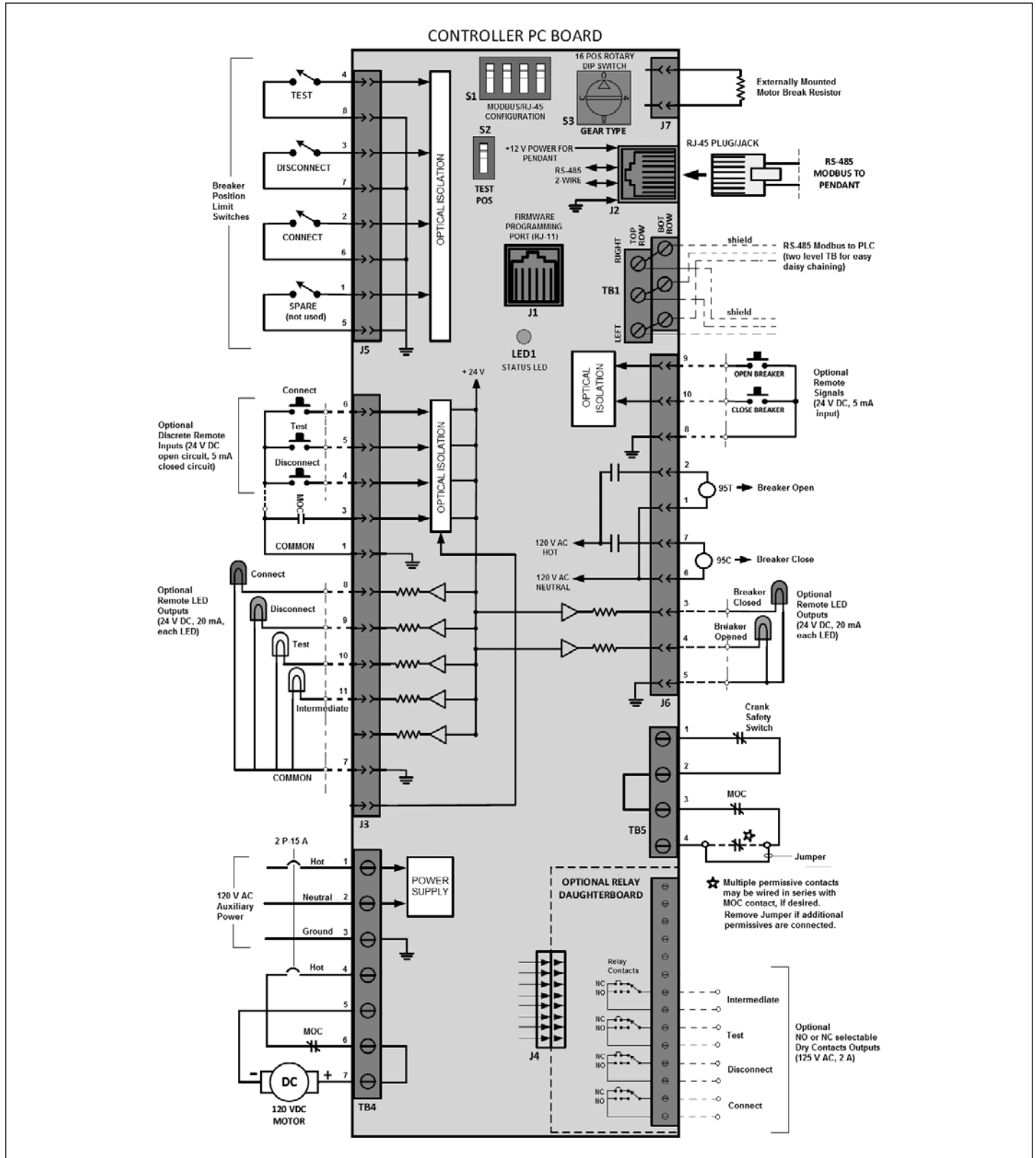


Figure 5.3-8. VC-W MR2 Controller Interface for a VCB with Distinct Test Position and Open/Close Functions

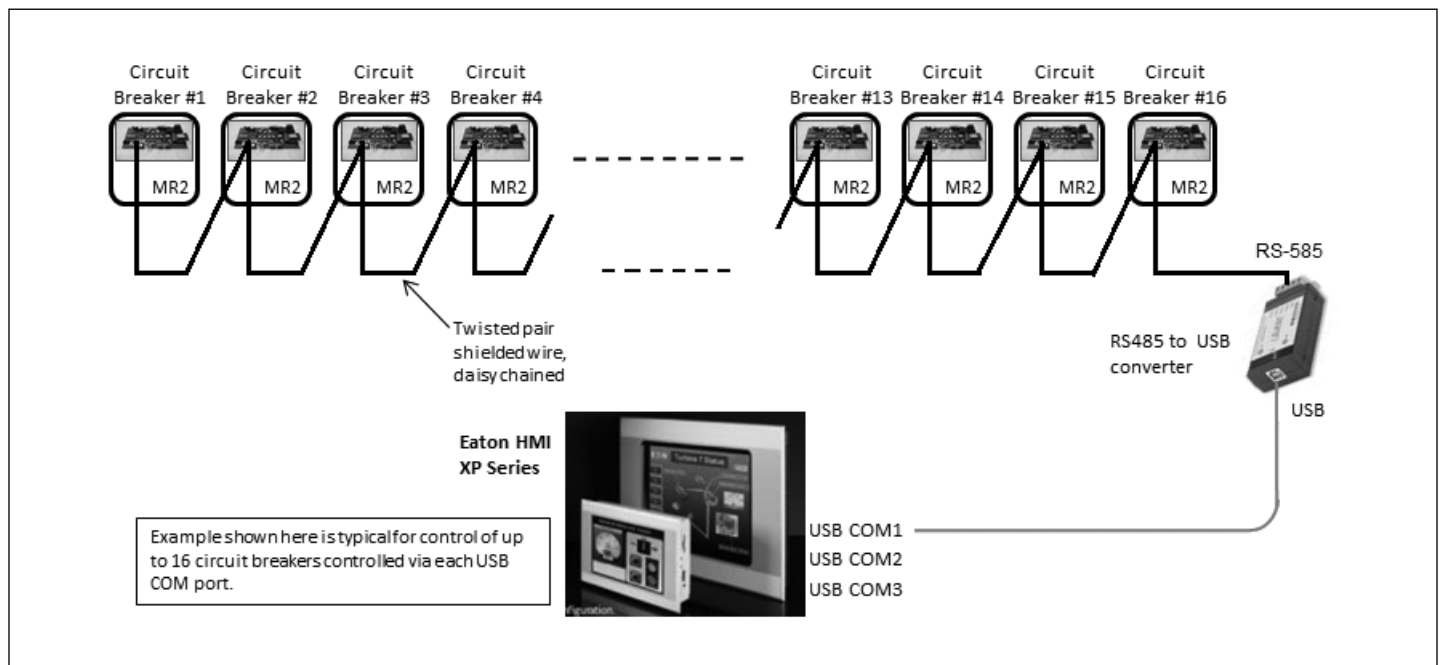


Figure 5.3-9. VC-W MR2 Typical Modbus Control Example

Accessories

Eaton 5–15 kV switchgear is provided with the following accessories as standard:

- One test jumper
- One levering crank
- One maintenance tool
- One lifting yoke (5–27 kV)
- One sets of rails (5–27 kV)

The following optional accessories are also available. Contact Eaton for additional information.

Optional Accessories

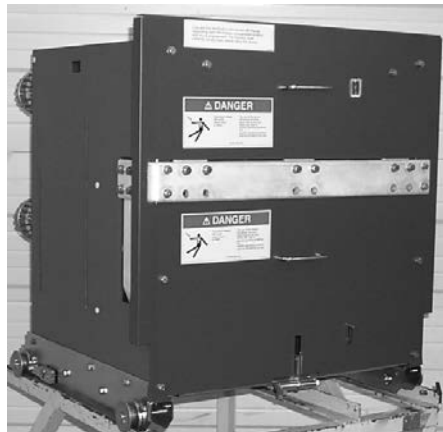
- Transport dolly (5–27 kV), (5–15 kV arc-resistant)
- Portable lifter (5–27 kV)
- Test cabinet
- Electrical levering device (5–38 kV)
- Ramp for lower breaker (5–27 kV), (5–15 kV arc-resistant)
- Manual or electrical ground and test device
- Hi-pot tester

Ground and Test Device

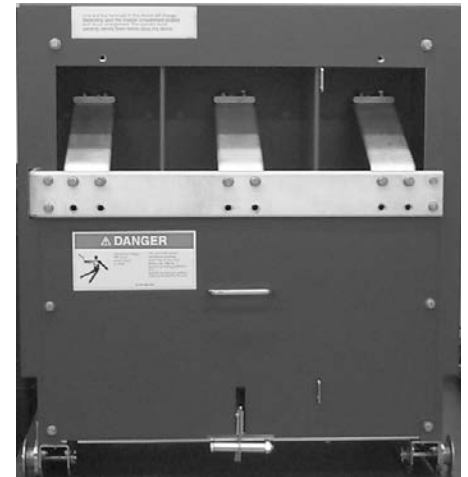
The ground and test device is a drawout element that may be inserted into a metal-clad switchgear housing in place of a circuit breaker to provide access to the primary circuits to permit the temporary connection of grounds or testing equipment to the high-voltage circuits. High potential testing of cable or phase checking of circuits are typical tests which may be performed. The devices are insulated to suit the voltage rating of the switchgear and will carry required level of short-circuit current.

Before using ground and test devices, it is recommended that each user develop detailed operating procedures consistent with safe operating practices. Only qualified personnel should be authorized to use ground and test devices.

Manual and electrical ground and test devices are available. These devices include six studs for connection to primary circuits. On the manual device, selection and grounding is accomplished by cable or bus bars connection. On electrical-type devices, grounding is accomplished by an electrically operated grounding switch.



5/15 kV Manual Type G&T Device



5/15 kV Manual G&T Device shown with Upper Terminals Grounded



5/15 kV Manual G&T Device shown with Lower Terminals Grounded

System Options

Partial Discharge Sensing and Monitoring for Switchgear



InsulGard Relay



RFCT Sensor

Partial Discharge Equipment



InsulGard Relay (PD Monitoring)

Partial Discharge in Switchgear

Partial discharge is a common name for various forms of electrical discharges such as corona, surface tracking, and discharges internal to the insulation. It partially bridges the insulation between the conductors. These discharges are essentially small arcs occurring in or on the surface of the insulation system when voltage stress exceeds a critical value. With time, airborne particles, contaminants and humidity lead to conditions that result in partial discharges. Partial discharges start at a low level and increase as more insulation becomes deteriorated. Examples of partial discharge in switchgear are surface tracking across bus insulation, or discharges in the air gap between the bus and a support, such as where a bus passes through an insulating window between the sections of the switchgear. If partial discharge activity is not detected and corrected, it can develop into a full-scale insulation failure followed by an electrical fault. Most switchgear flashover and bus failures are a result of insulation degradation caused by various forms of partial discharges.

Sensing and Monitoring

Eaton's Type VCP-W metal-clad switchgear (2.4–38 kV) is corona-free by design. Corona emissions within the standard VacClad switchgear assemblies have been eliminated or reduced to very low levels by special fabrication and assembly techniques, such as rounding and buffing of all sharp copper edges at the joints, employing star washers for bolting metal barriers, and using specially crafted standoff insulators for primary bus supports. By making switchgear assemblies corona-free, Eaton has made its standard switchgear more reliable. However, as indicated above, with time, airborne particles, contaminants and humidity lead to conditions that cause partial discharges to develop in switchgear operating at voltages 4000 V and above. Type VC-W switchgear can be equipped with factory-installed partial discharge sensors and partial discharge sensing relay for continuous monitoring of the partial discharges under normal operation. Timely detection of insulation degradation through increasing partial discharges can identify potential problems so that corrective actions can be planned and implemented long before permanent deterioration develops. Partial discharge detection can be the foundation of an effective predictive maintenance program. Trending of partial discharge data over time allows prediction of failures, which can be corrected before catastrophic failure occurs.

The PD sensing and monitoring system is optional. It consists of Eaton's InsulGard™ Relay and PD sensors specifically developed for application in the switchgear to work with the relay.

Partial discharges within the switchgear compartment are detected by installation of a small donut type radio frequency current transformer (RFCT) sensor over floating stress shields of the specially designed bus or line side primary bushings. Partial discharges in customer's power cables (external discharges) are detected by installation of the RFCT around ground shields of the incoming or outgoing power cable terminations.

In 5/15 kV switchgear (refer to **Figure 5.3-11**), primary epoxy bushings with stress shield and RFCT sensors for measurement of internal as well as external partial discharges are all optional. InsulGard relay is also optional. When specified, one set of primary epoxy bushings (located on bus side) with stress shield and associated RFCT sensor is provided at every two vertical sections. An additional RFCT sensor for each incoming and outgoing power cable circuits can be provided as required. The RFCT output signals can be connected directly to InsulGard relay for continuous monitoring of partial discharges or can be used for periodic field measurements.

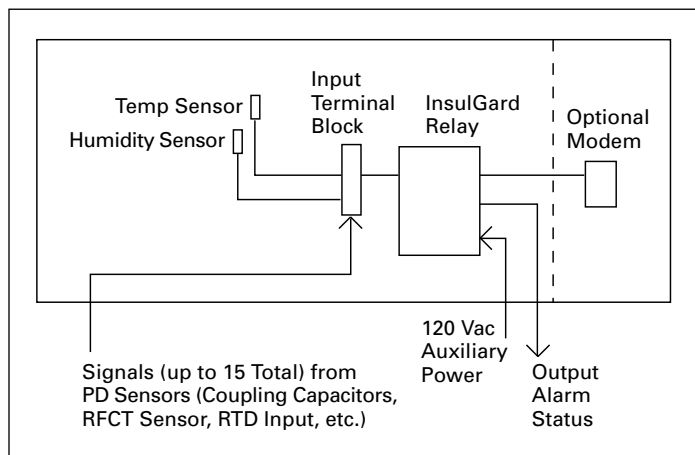


Figure 5.3-10. InsulGard Relay System

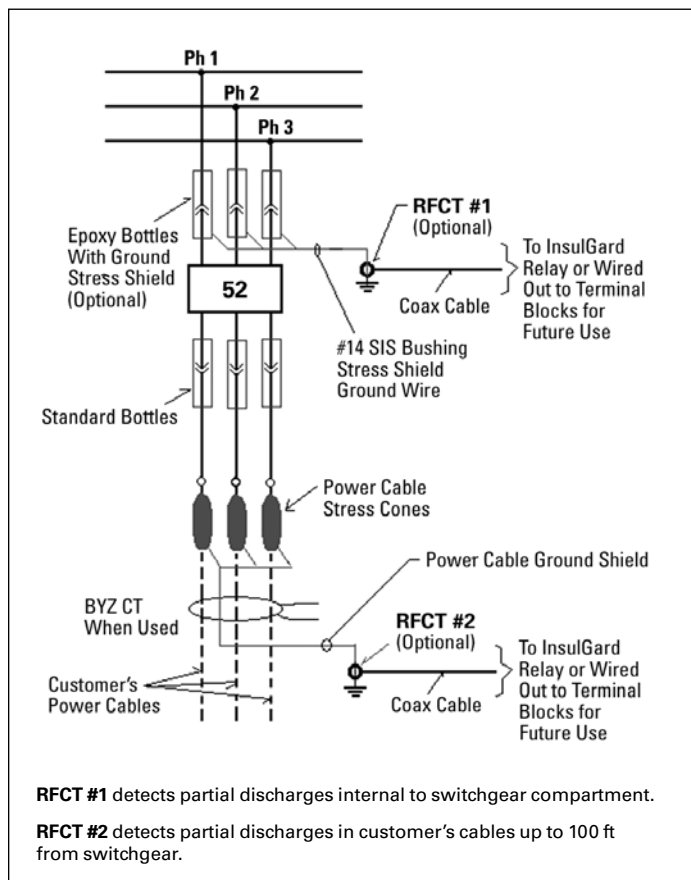


Figure 5.3-11. Typical Partial Discharge Sensor Connections (5–15 kV Switchgear)

Note: Use one set of epoxy bottles with ground stress shield on bus side (either in the top or bottom compartment) at every two vertical sections. Use standard bottles at all other locations.

Partial Discharge Sensors and Monitoring for Switchgear

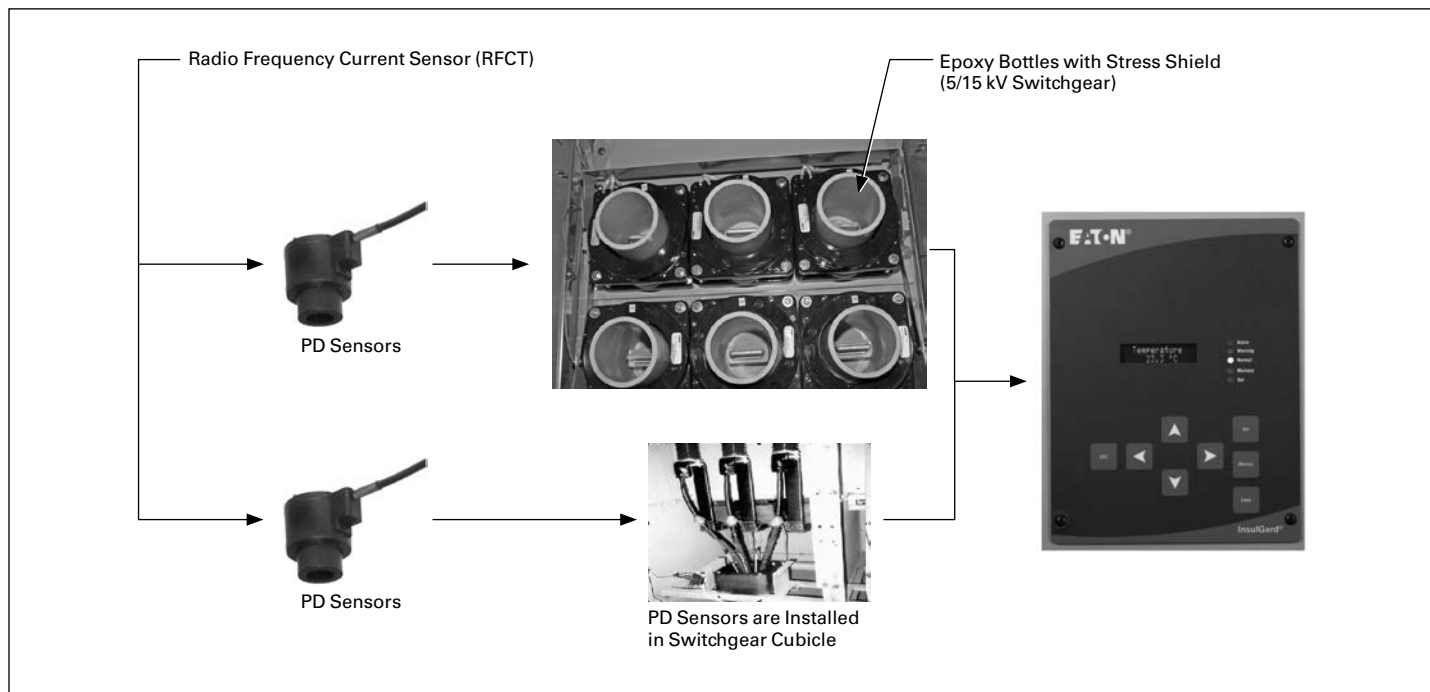


Figure 5.3-12. How the Process Works—Sensing and Data Collection

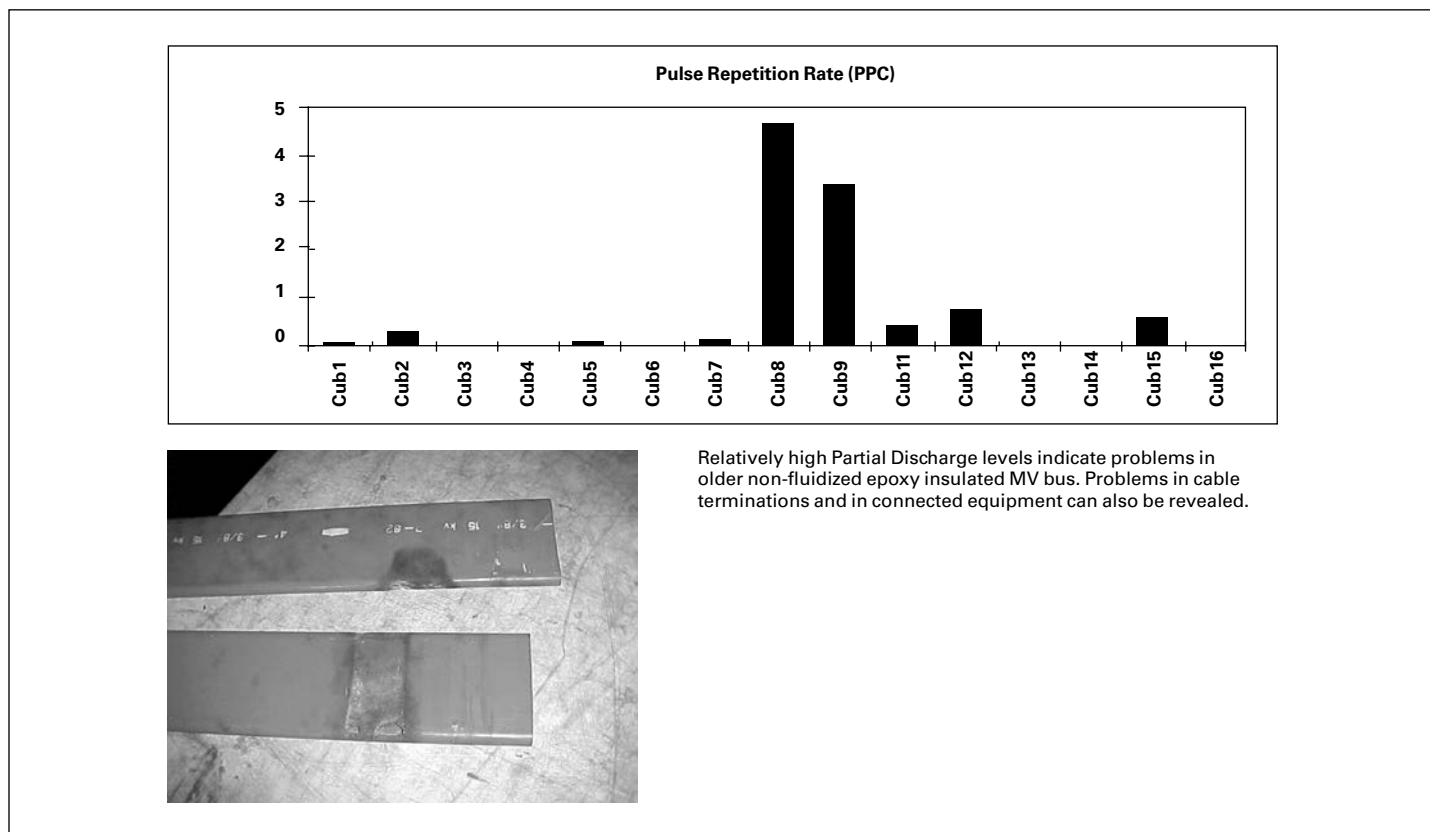


Figure 5.3-13. How the Process Works—Data Analysis and Report (Sample)

Standard

Typical Application Layouts

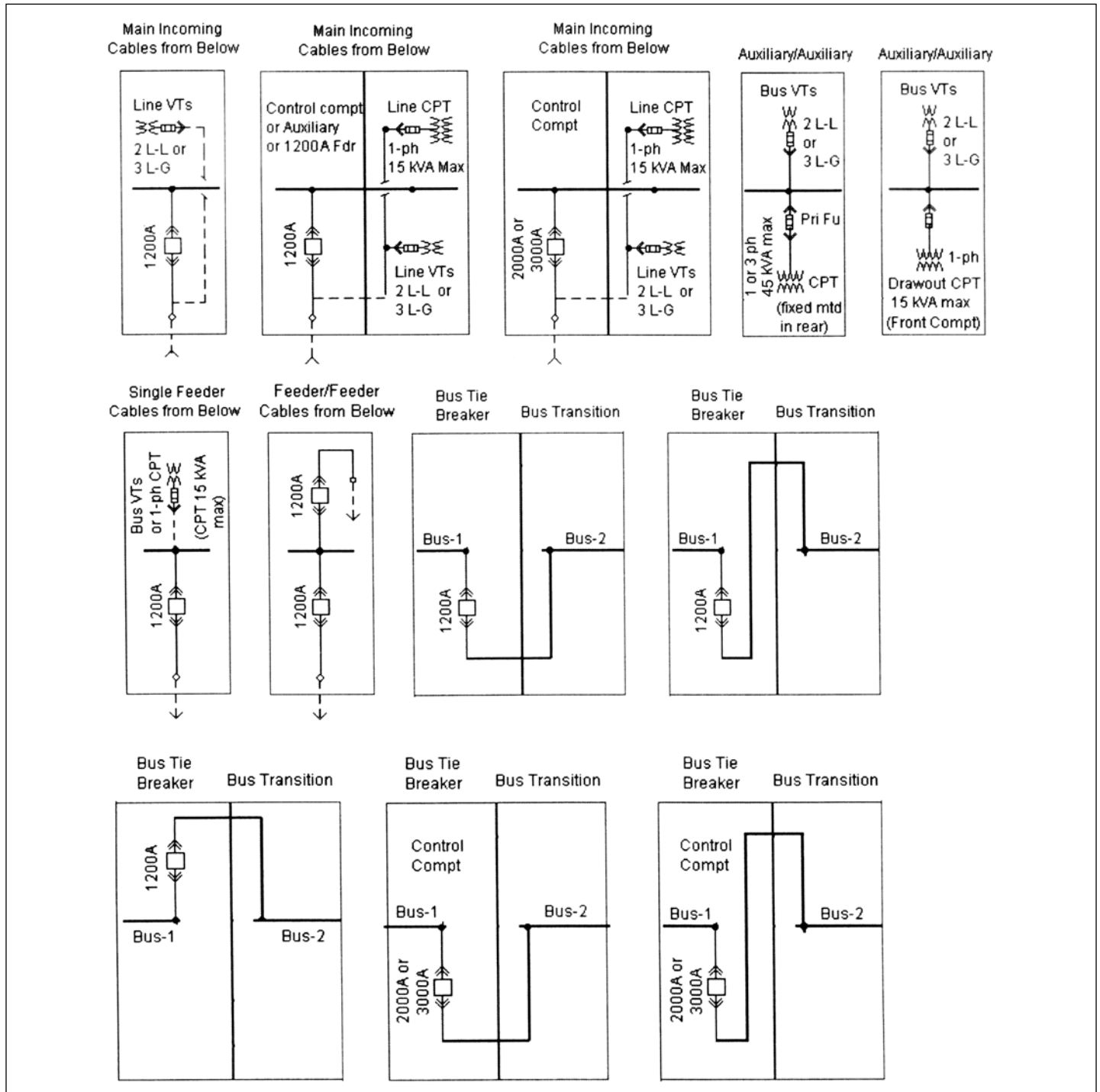


Figure 5.3-14. Typical Arc-Resistant Switchgear Application Layouts—5 and 15 kV

Notes:

1. Maximum number of CTs: Two sets of standard or one set of high accuracy CTs can be installed on each side of the circuit breaker.
2. Bottom entry is standard for all power cables. In breaker over breaker arrangement, maximum number of cables is limited to **two per phase for each breaker**.
3. All lineups shown can be provided in mirrored configuration.
4. Refer to **Figure 5.3-17** to **Figure 5.3-22** for dimensions.

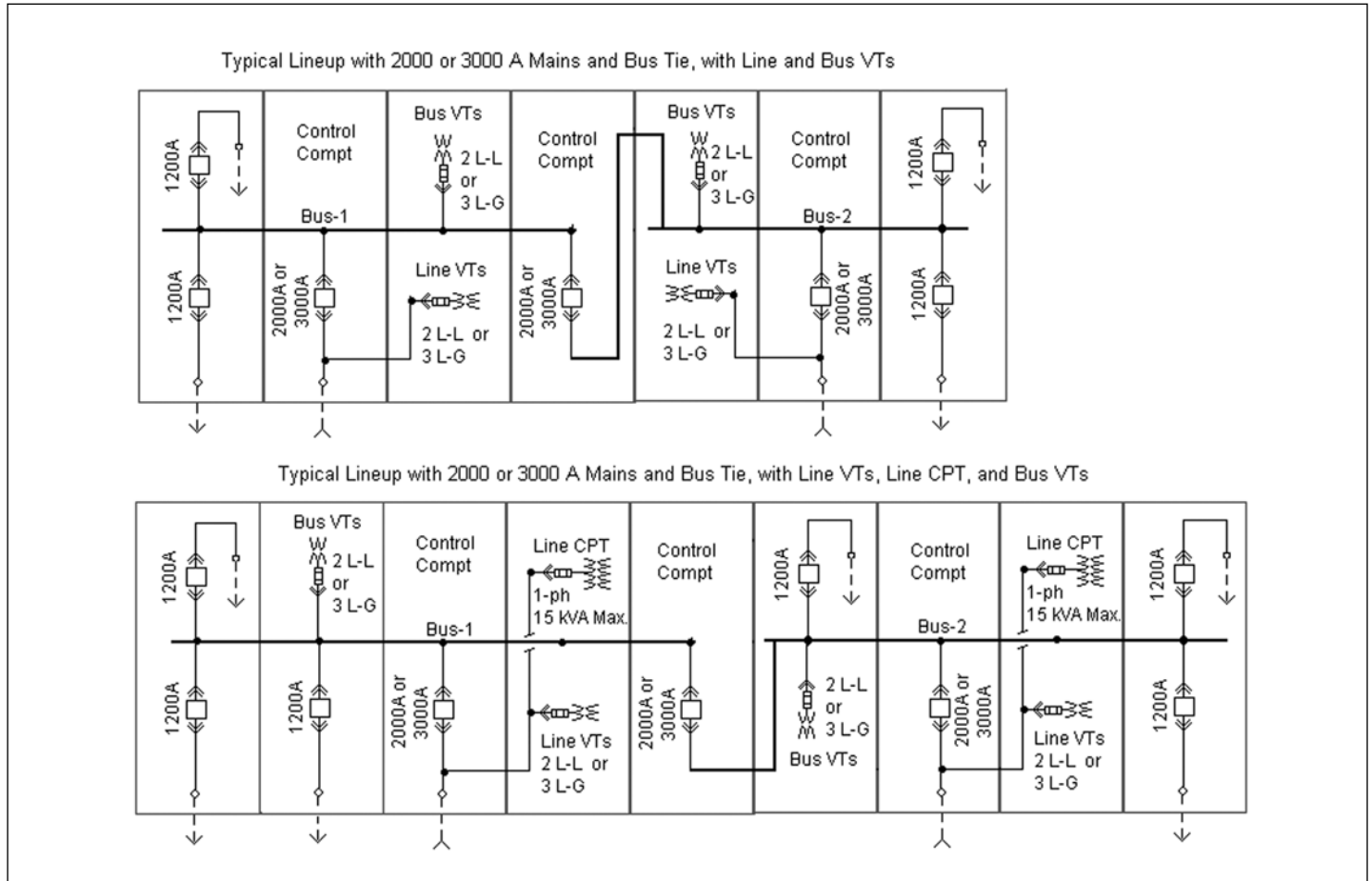


Figure 5.3-15. Typical Arc-Resistant Switchgear Application Layouts—5 and 15 kV

Notes:

1. Maximum number of CTs: Two sets of standard or one set of high accuracy CTs can be installed on each side of the circuit breaker.
2. Bottom entry is standard for all power cables. In breaker over breaker arrangement, maximum number of cables is limited to **two per phase for each breaker**.
3. All lineups shown can be provided in mirrored configuration.
4. Refer to **Figure 5.3-17** to **Figure 5.3-22** for dimensions.

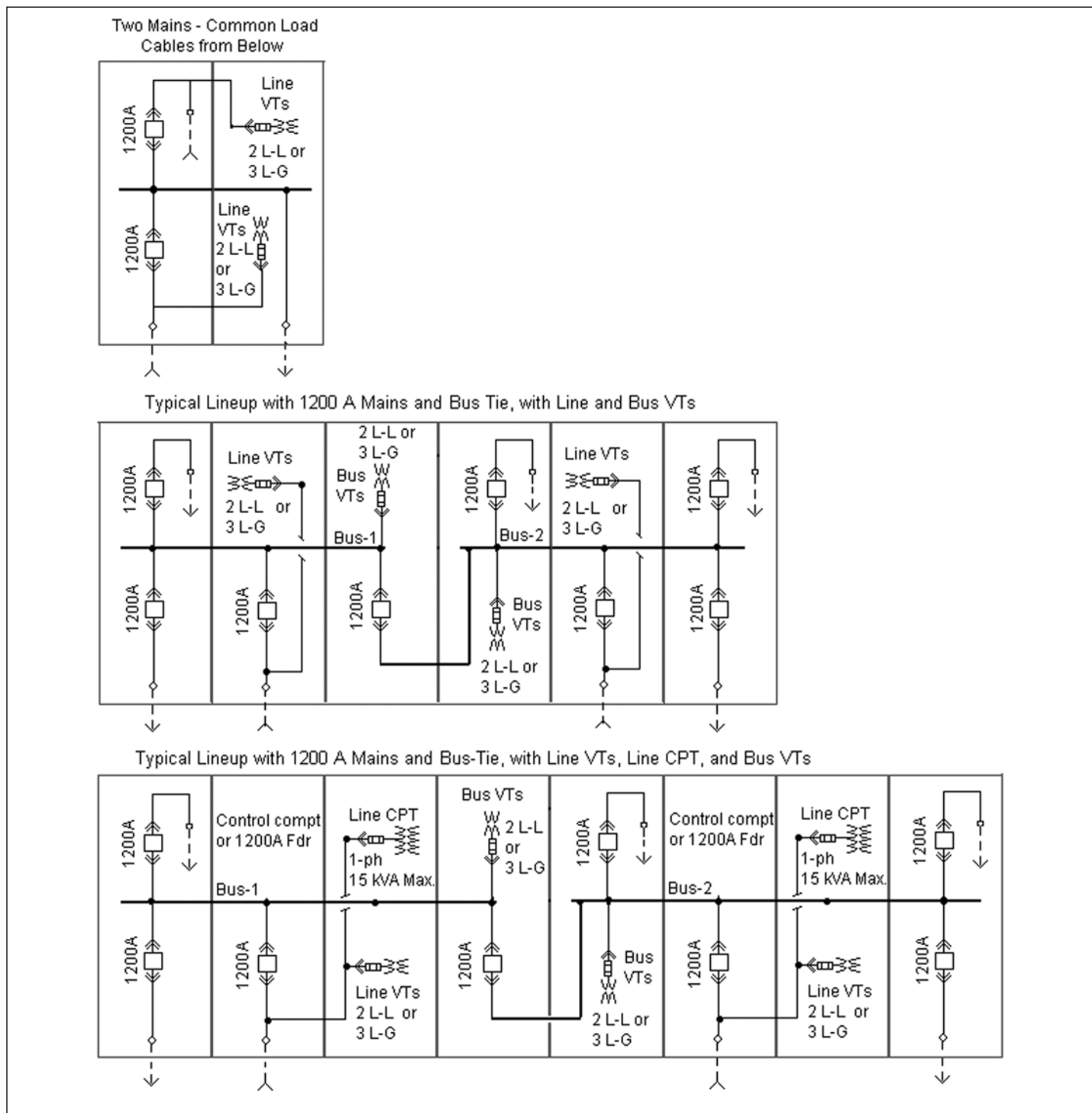


Figure 5.3-16. Typical Arc-Resistant Switchgear Application Layouts—5 and 15 kV

Notes:

1. Maximum number of CTs: Two sets of standard or one set of high accuracy CTs can be installed on each side of the circuit breaker.
2. Bottom entry is standard for all power cables. In breaker over breaker arrangement, maximum number of cables is limited to **two per phase for each breaker**.
3. All lineups shown can be provided in mirrored configuration.
4. Refer to **Figure 5.3-17** to **Figure 5.3-22** for dimensions.

Available Configurations

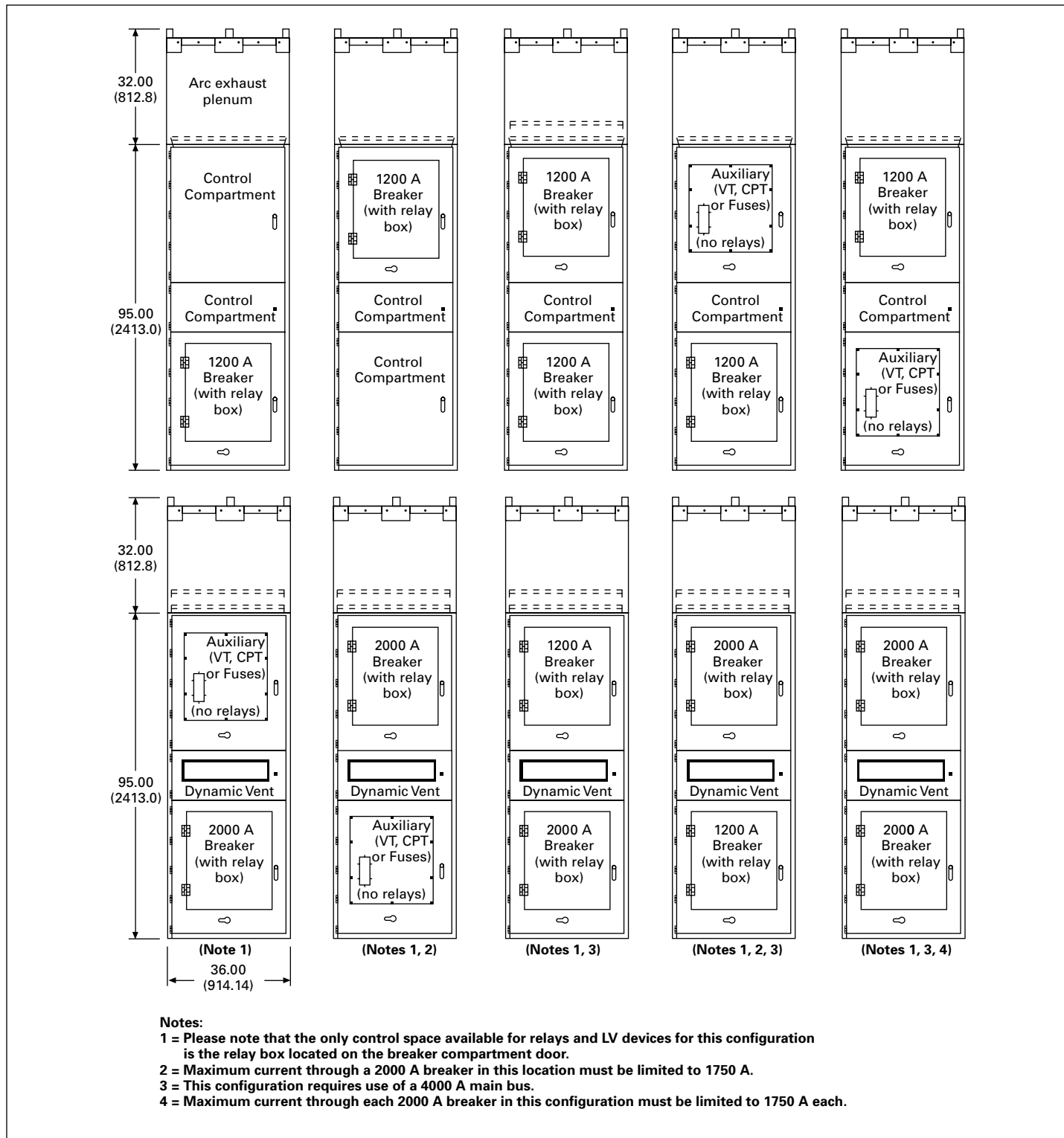


Figure 5.3-17. Available Arc-Resistant Switchgear Configurations (Front Views)—5 and 15 kV

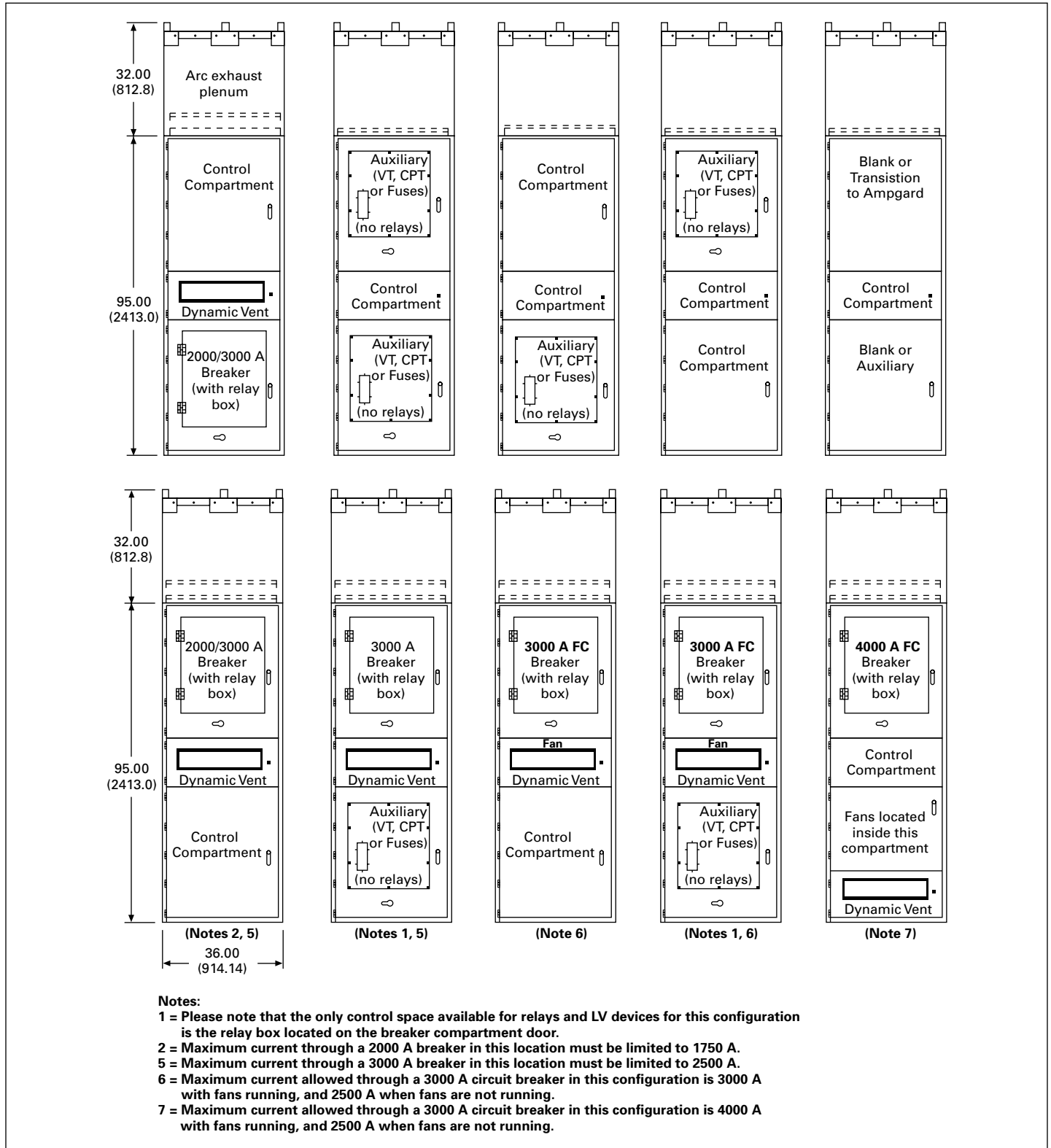


Figure 5.3-17. Available Arc-Resistant Switchgear Configurations (Front Views)—5 and 15 kV (Continued)

Typical Sectional Side Views

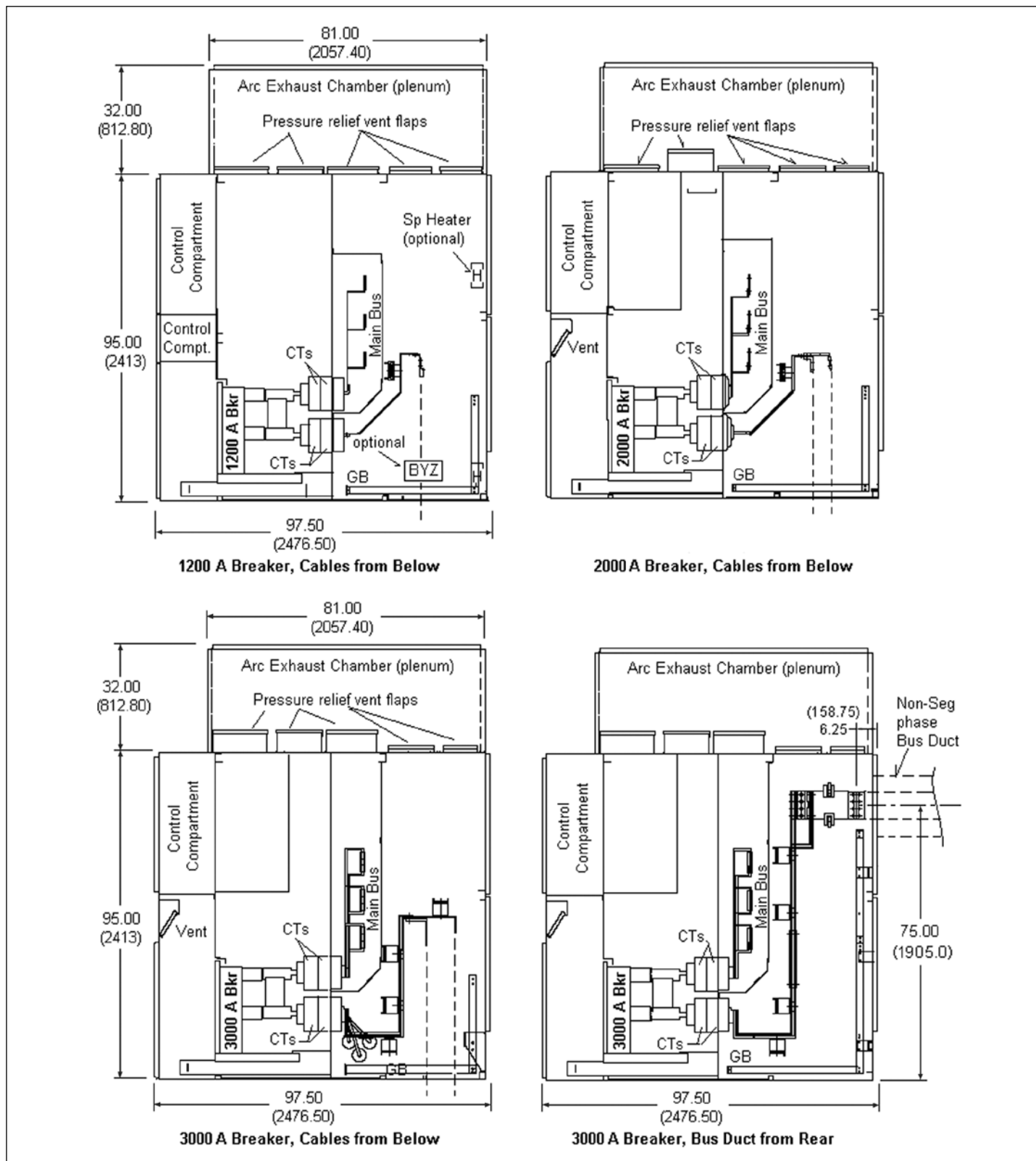


Figure 5.3-18. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

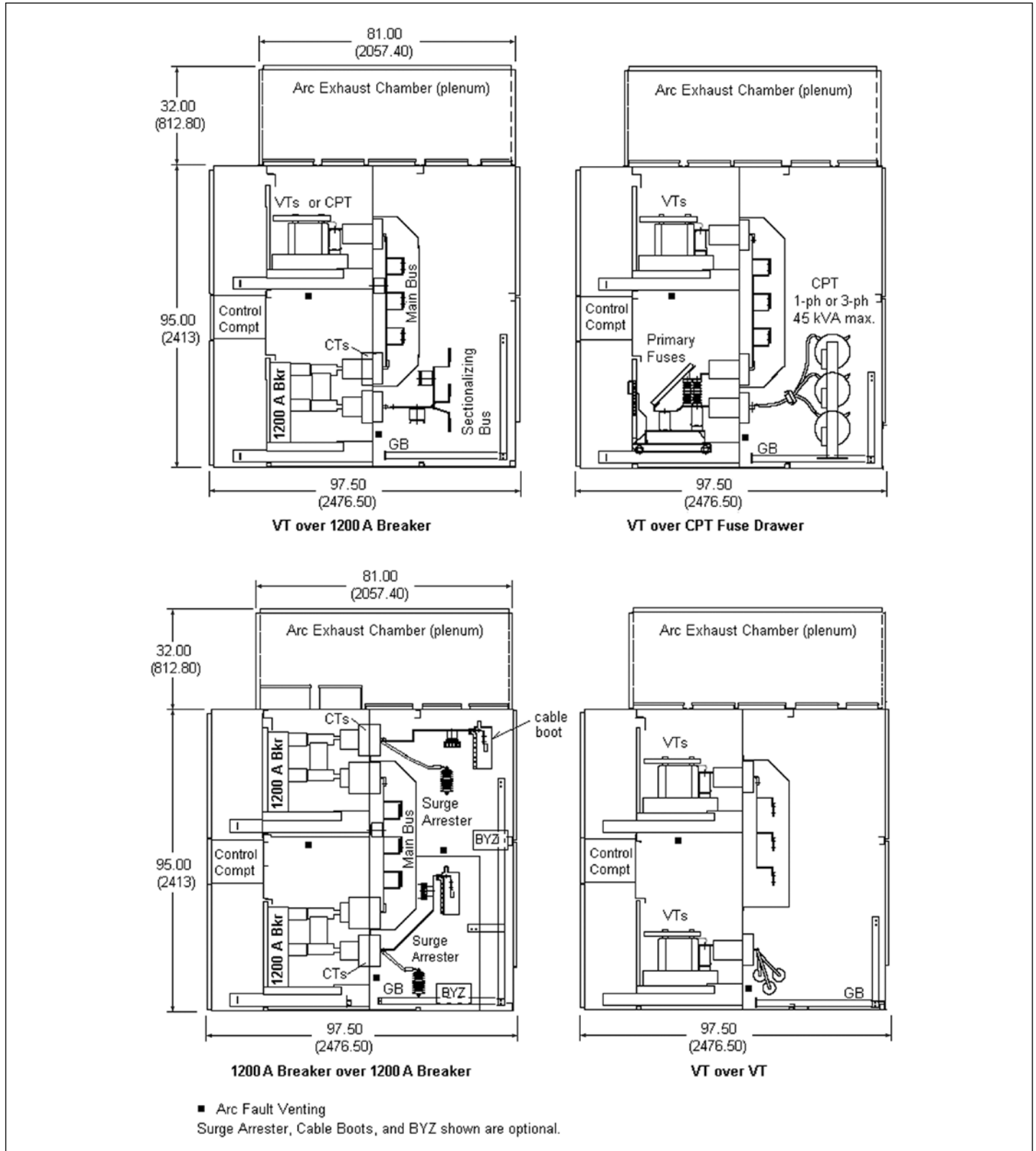


Figure 5.3-19. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

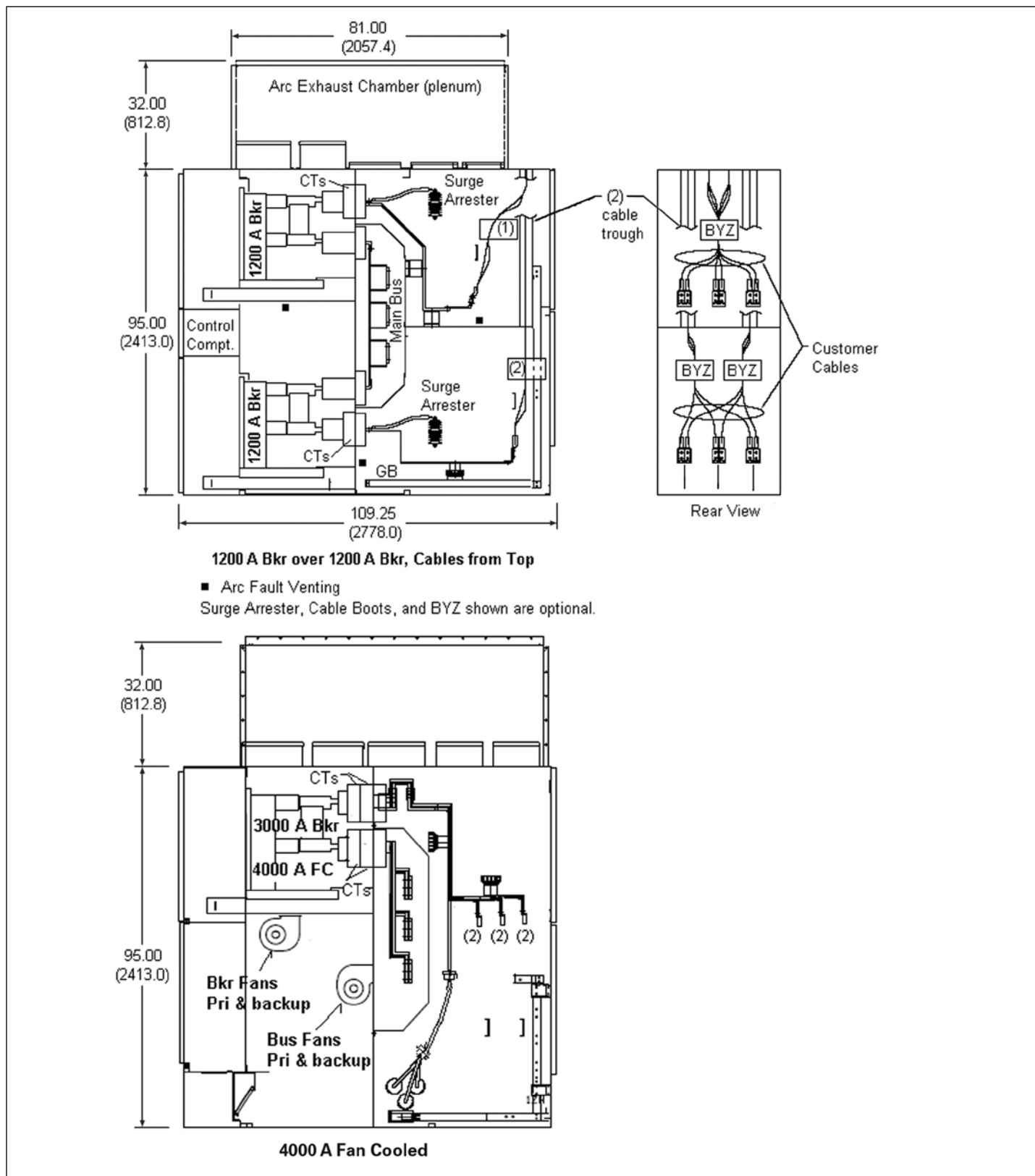


Figure 5.3-20. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

Typical Top Plan—Dimensions in Inches (mm)

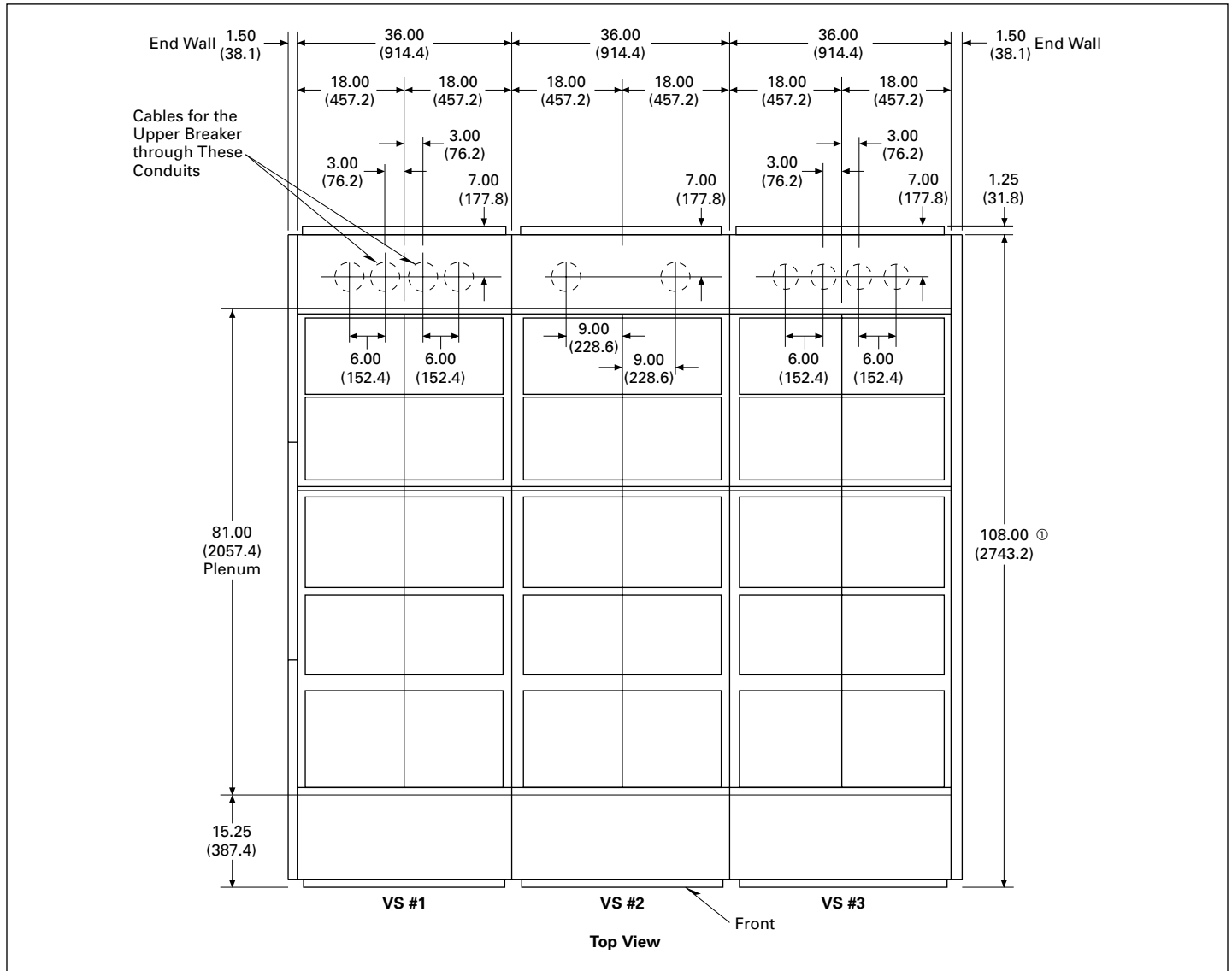


Figure 5.3-21. Typical Arc-Resistant Switchgear, Top Entry Cables—Typical Conduit Entrance Locations—5 and 15 kV

Note: For switchgear with enclosure arc ratings of up to 41 kA rms symmetrical, minimum two vertical sections and one arc duct exit are required. For switchgear with enclosure arc ratings of 50 kA rms symmetrical or higher, minimum three vertical sections and two arc duct exits are required.

① Depth shown is based on use of maximum one 500 kCM per phase, or two 250 kCM per phase power cables for each breaker entering from the top; otherwise, use structures with 121.50-inch (3086.1-mm) depth.

Typical Floor Plan—Dimensions in Inches (mm)

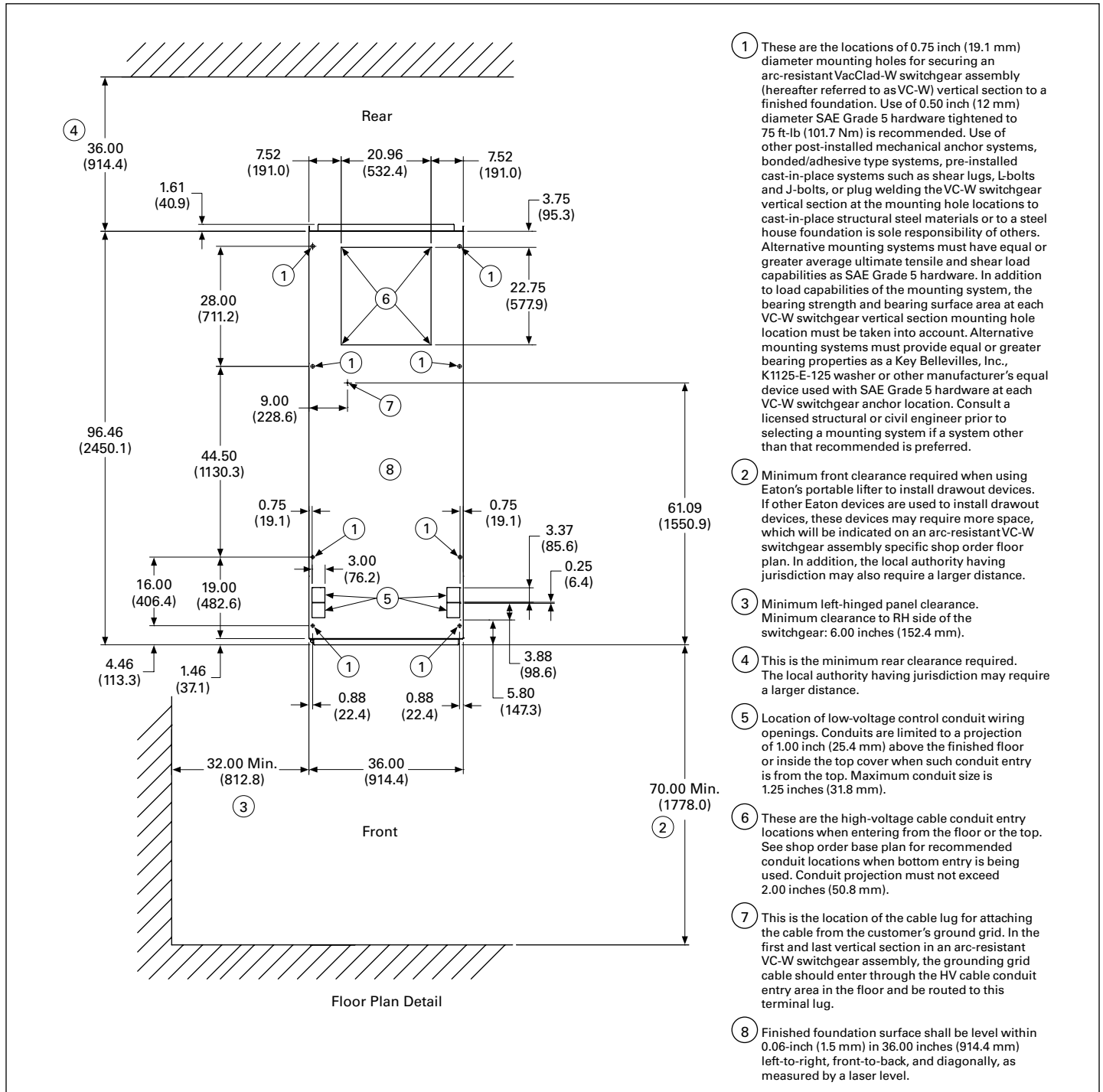


Figure 5.3-22. Typical Arc-Resistant Switchgear Floor Plan—5 and 15 kV

Typical Weights

Table 5.3-15. Assemblies (Less Breakers) ①②③

Type of Vertical Section	Main Bus Rating	Indoor Structure 36.00-Inch (914.4 mm) W 97.50-Inch (2476.5 mm) D	Indoor Structure 36.00-Inch (914.4 mm) W 109.50-Inch (2781.3 mm) D	Indoor Structure 36.00-Inch (914.4 mm) W 121.50-Inch (3086.1 mm) D
	Amperes	Lb (kg)	Lb (kg)	Lb (kg)
Breaker/breaker	1200	2800 (1271)	3025 (1374)	3175 (1441)
	2000	2900 (1317)	3175 (1441)	3375 (1532)
	3000	3000 (1362)	3275 (1487)	3475 (1578)
	4000	3100 (1407)	3375 (1532)	3575 (1623)
Blank/breaker or breaker/blank	1200	2700 (1226)	2900 (1317)	3125 (1419)
	2000	2800 (1271)	3125 (1419)	3175 (1441)
	3000	2900 (1317)	3150 (1430)	3325 (1510)
	4000	3000 (1362)	3275 (1487)	3475 (1578)
Auxiliary/breaker or breaker/auxiliary	1200	2650 (1203)	2850 (1294)	2975 (1351)
	2000	2750 (1248)	2975 (1351)	3225 (1464)
	3000	2850 (1294)	3100 (1407)	3275 (1487)
	4000	2950 (1339)	3225 (1464)	3450 (1566)
Auxiliary/auxiliary	1200	2600 (1180)	2800 (1271)	2925 (1328)
	2000	2700 (1226)	2925 (1328)	3175 (1441)
	3000	2800 (1271)	3050 (1385)	3225 (1464)
	4000	2900 (1317)	3175 (1441)	3375 (1532)
Blank/auxiliary or auxiliary/blank	1200	2500 (1135)	2700 (1226)	2825 (1283)
	2000	2600 (1180)	2825 (1283)	2975 (1351)
	3000	2700 (1226)	2950 (1339)	3125 (1419)
	4000	2800 (1271)	3075 (1396)	3275 (1487)
Blank/blank	1200	2500 (1135)	2700 (1226)	2825 (1283)
	2000	2600 (1180)	2825 (1283)	2975 (1351)
	3000	2700 (1226)	2950 (1339)	3125 (1419)
	4000	2800 (1271)	3075 (1396)	3275 (1487)

- ① Add weights of end-wall to left and right end structures as follows:
 350 Lb (159.1 kg) for 97.50-inch (2476.5) D structures.
 390 Lb (177.3 kg) for 109.50-inch (2781.3) D structures.
 430 Lb (195.4 kg) for 121.50-inch (3086.1) D structures.
- ② Add plenum weight as follows:
 300 Lb (136.4 kg) to left and right end structures.
 200 Lb (91.0 kg) to each intermediate structures.
- ③ Add arc duct assembly weight as follows:
 200.00 Lb (91.0 kg) for standard 51.00-inch (1295.4 mm) arc exhaust duct assembly.
 30.00 Lb (14.0 kg) per foot for additional arc duct.

Control Power Requirements

Table 5.3-16. VCP-W Breaker Stored Energy Mechanism Control Power Requirements

Rated Control Voltage	Spring Charging Motor			Close or Trip Amperes	UV Trip mA Maximum	Voltage Range		Indicating Light Amperes
	Inrush Amperes	Run Amperes	Average Run Time, Sec.			Close	Trip	
48 Vdc	36.0	9	6	16	200	38–56	28–56	0.02
125 Vdc	16.0	4	6	7	80	100–140	70–140	0.02
250 Vdc	9.2	2	6	4	40	200–280	140–280	0.02
120 Vac	16.0	4	6	6	—	104–127	104–127	0.02
240 Vac	9.2	2	6	3	—	208–254	208–254	0.02

Typical Schematics

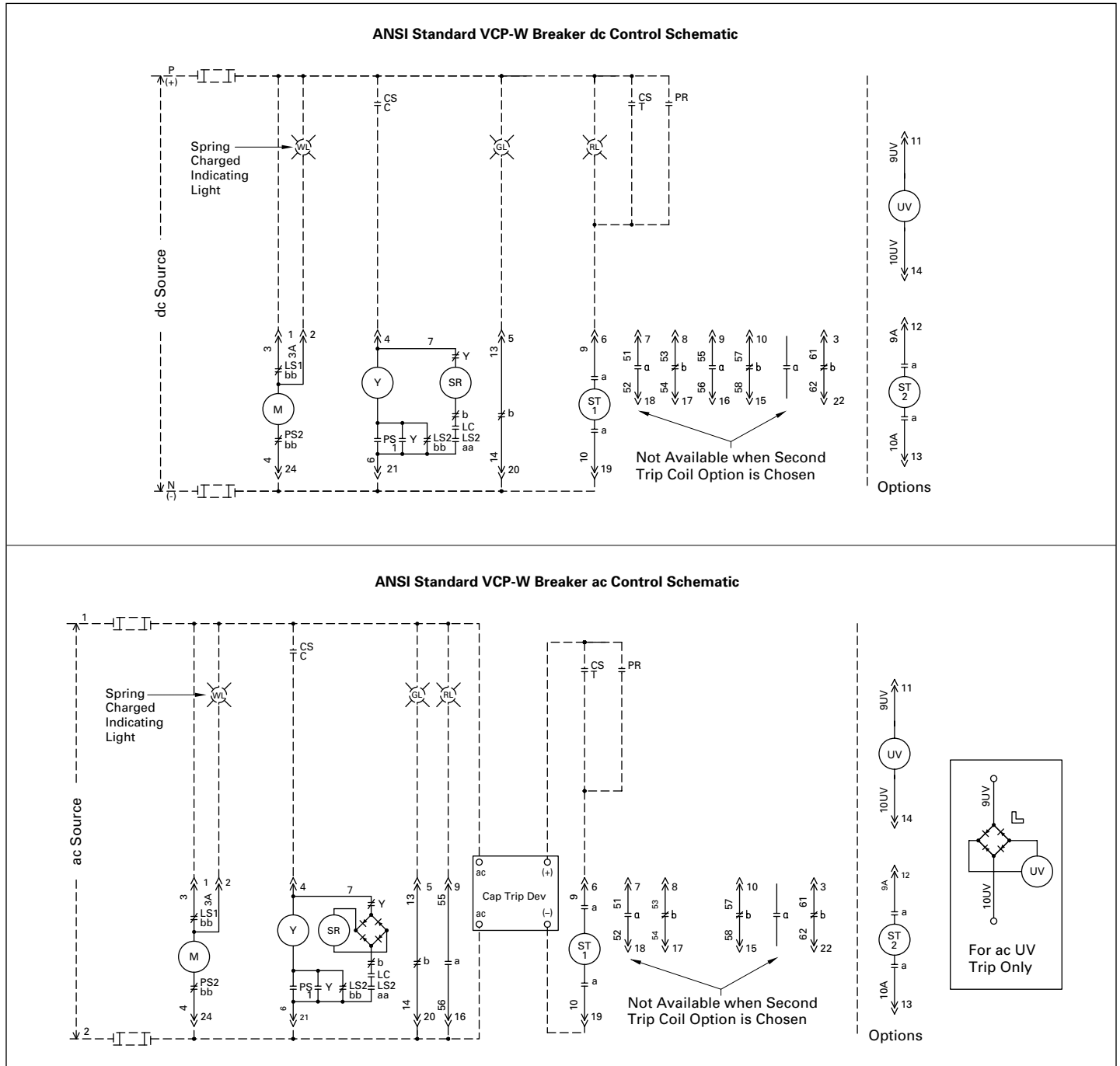
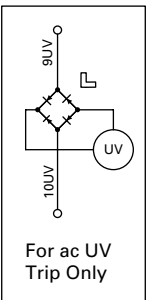


Figure 5.3-23. Typical 5/15/27 kV VCP-W “dc” and “ac” Control Schematics

Legend: **CS** = Breaker Control Switch–Close
C = Breaker Control Switch–Close
CS = Breaker Control Switch–Trip
T = Breaker Control Switch–Trip
Y = Anti Pump Relay
SR = Spring Release Coil (Coil)
M = Spring Charge Motor
ST = Shunt Trip
PR = Protective Relay
 \wedge = Secondary Disconnect

Operation: **LS1** = Closed until springs are fully charged.
bb = Closed until springs are fully charged.
LS2 = Open until springs are fully charged.
aa = Open until springs are fully charged.
LS2 = Closed until springs are fully charged.
bb = Closed until springs are fully charged.
LC = Open until mechanism is reset.
PS1 = Open in all except between “Test” and “Connected” positions.
PS2 = Closed in all except between “Test” and “Connected” positions.



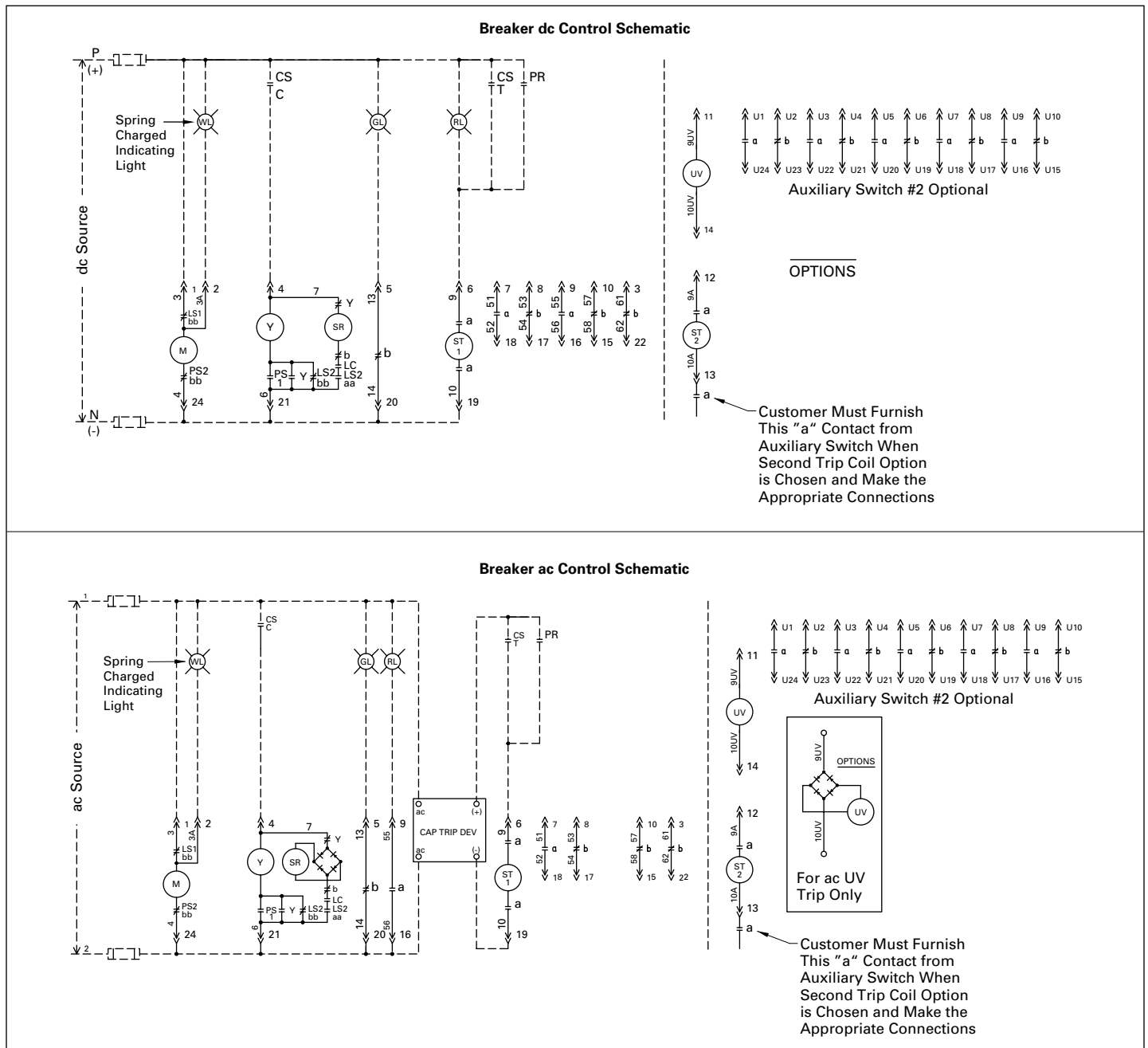


Figure 5.3-24. Typical 38 kV VCP-W "dc" and "ac" Control Schematics

Legend: CS = Breaker Control Switch–Close
 C = Breaker Control Switch–Close
 CS = Breaker Control Switch–Trip
 T = Breaker Control Switch–Trip
 Y = Anti Pump Relay
 SR = Spring Release Coil (Coil)
 M = Spring Charge Motor
 ST = Shunt Trip
 PR = Protective Relay
 ^ = Secondary Disconnect

Operation: LS1 = Closed until springs are fully charged.
 bb = Closed until springs are fully charged.
 LS2 = Open until springs are fully charged.
 aa = Open until springs are fully charged.
 LS2 = Closed until springs are fully charged.
 bb = Closed until springs are fully charged.
 LC = Open until mechanism is reset.
 PS1 = Open in all except between "Test" and "Connected" positions.
 PS2 = Closed in all except between "Test" and "Connected" positions.

