BID FORM FOR PROCUREMENT CONTRACT

The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

ARTICLE 1—BUYER AND BIDDER

1.01 This Bid is submitted to:

City of Crete, Crete, Nebraska

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into a Procurement Contract with Buyer in the form included in the Procurement Bidding Documents, and to furnish the Goods and Special Services as specified or indicated in the Procurement Bidding Documents, for the prices and within the times indicated in this Bid, and in accordance with the other terms and conditions of the Procurement Bidding Documents.

ARTICLE 2—BASIS OF BID

2.01 *Lump Sum Bids*

A. Bidder will furnish the Goods and Special Services in accordance with the Procurement Contract Documents for the following Procurement Contract Price(s) for Doane Substation Medium Voltage Switchgear:

1. Lump Sum Bid Price (Base Bid and Alternates)

Price Includes 7.5% Sales tax ($67,125)
Price Does NOT Include Concrete, Concrete Pads, Power Cable, Power Cable Terminations or Grounding

Base Bid 15kV Switchgear:

BASE BID LUMP SUM	$ 962,125.00

Alternate Bid 35kV Switchgear:

ALTERNATE BID LUMP SUM	$ No Bid

ARTICLE 3—TIME OF COMPLETION

3.01 Bidder agrees that the furnishing of Goods and Special Services will conform to the schedule of Procurement Contract Times set forth in Article 2 of the Procurement Agreement.

3.02 Bidder accepts the provisions of the Procurement Agreement as to liquidated damages.

ARTICLE 4—ATTACHMENTS TO THIS BID

4.01 The following documents are attached to and made a condition of this Bid:

A. Required Bid security in the form prescribed in the Instructions to Bidders.

B. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such authority within the time for acceptance of Bids.

C. Equipment Data Sheets.

D. Required Bidder Qualification Statement with supporting data.

E. Technical information required for comparative evaluation as described in Instruction to Bidders, and more specifically in Specifications.

ARTICLE 5—BIDDER'S ACKNOWLEDGMENTS

5.01 Bidder accepts all terms and conditions of the Instructions to Bidders. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period that Bidder may agree to in writing upon request of Buyer.

5.02 Bidder has examined and carefully studied the Procurement Bidding Documents, the related data identified in the Procurement Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged:

Addendum No.	Addendum Date
1	5/19/23
2	5/25/23

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Bidder's Representations*

A. In submitting this Bid, Bidder represents that:

1. Bidder has examined and carefully studied the Procurement Contract Documents.

2. If required by the Instructions to Bidders to visit the Point of Destination and the site where the Goods are to be installed or Special Services will be provided, or if, in Bidder's judgment, any observable local or site conditions may affect the delivery, cost, progress, or furnishing of the Goods and Special Services, then Bidder has visited the Point of Destination and site where the Goods are to be installed or Special Services will be provided (as applicable) and become familiar with and is satisfied as to the observable local and site conditions that may affect delivery, cost, progress, and furnishing of the Goods and Special Services.

3. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect the cost, progress, and performance of Seller's obligations under the Procurement Contract.

4. Bidder has carefully studied, considered, and correlated the information known to Bidder with respect to the effect of such information on the cost, progress, and performance of Seller's obligations under the Procurement Contract.

5. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Procurement Contract Documents, and the written resolution (if any) thereof by Engineer is acceptable to Bidder.

6. The Procurement Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance of Seller's obligations under the Procurement Contract.

7. The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of the Bidding Requirements, that without exception the Bid (including all Bid prices) is premised upon furnishing the Goods and Special Services as required by the Procurement Contract Documents.

6.02 *Bidder's Certifications*

A. Bidder certifies that:

1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation;

2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

3. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Procurement Contract. For the purposes of this Paragraph 6.02.A.4:

a. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process;

b. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Buyer, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Buyer of the benefits of free and open competition;

c. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Buyer, a purpose of which is to establish bid prices at artificial, non-competitive levels; and

d. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process.

This Bid is offered by:

Bidder:

Harold K. Scholz Company

(typed or printed name of organization)

By: Ross Scholz

(individual's signature)

Date: 6/29/23

(date signed)

Name: Ross Scholz

(typed or printed)

Title: President

(typed or printed)

(If Bidder is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest: Brandon Christensen

(individual's signature)

Title: Project Manager/ Estimator

(typed or printed)

Address for giving notices:

7800 Serum Ave, Ralston NE, 68127

Designated Representative:

Name: Ross Scholz

(typed or printed)

Title: President

(typed or printed)

Address:

7800 Serum Ave, Ralston NE, 68127

Phone: 402-339-7600

Email: Ross@hkscholz.com

License No.:

Classification:

Limitation:

BID BOND

Any singular reference to Bidder, Surety, Owner or other party shall be considered plural where applicable.

BIDDER *(Name and Address)*:
Harold K Scholz Company

7800 Serum Ave Ralston, NE 68127

SURETY *(Name, and Address of Principal Place of Business)*:
Universal Surety Company

1010 Lincoln Mall Suite #101 Lincoln, NE 68508

OWNER *(Name and Address)*:
City of Crete, P.O. Box 243, E 13, Crete, NE 68333

BID

Bid Due Date: 05/31/2023

Description *(Project Name— Include Location)*:
Doane Substation Medium Voltage Switchgear

BOND

Bond Number:

Date: 05/31/2023

Penal sum Five Percent (5% of Bid Estimate) $
(Words) (Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER	**SURETY**
Harold K Scholz Company (Seal)	Universal Surety Company (Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: Ann Hough	By: Charlotte Ahrenholtz
Signature	Signature (Attach Power of Attorney)
Ann Hough	Charlotte Ahrenholtz
Print Name	Print Name
Treasurer	Attorney-In-Fact
Title	Title
Attest: Denise Scholz	Attest:
Signature	Signature
Title Corp Secr.	Title witness

Note: Addresses are to be used for giving any required notice.
Provide execution by any additional parties, such as joint venturers, if necessary.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

3.1 Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or

3.2 All Bids are rejected by Owner, or

3.3 Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from the Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after the Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

UNIVERSAL SURETY COMPANY

Lincoln, Nebraska

POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS:

That the **UNIVERSAL SURETY COMPANY**, a corporation of the State of Nebraska having its principal office in the City of Lincoln, Nebraska, pursuant to the following Bylaw, which was adopted by the Board of Directors of the said Company on July 23, 1981, to wit:

"Article V-Section 6. RESIDENT OFFICERS AND ATTORNEYS-IN-FACT. The President or any Vice President, acting with any Secretary or Assistant Secretary, shall have the authority to appoint Resident Vice Presidents and Attorneys-In-Fact, with the power and authority to sign, execute, acknowledge and deliver on its behalf, as Surety: Any and all undertakings of suretyship and to affix thereto the corporate seal of the corporation. The President or any Vice President, acting with any Secretary or Assistant Secretary, shall also have the authority to remove and revoke the authority of any such appointee at any time."

does hereby make, constitute and appoint

Robert W. Hansen, Jr. or Charlotte Ahrenholtz, Omaha, Nebraska

its true and lawful Attorney(s)-in-Fact, to make, execute, seal and deliver for and on its behalf, as Surety:

Any and all undertakings of suretyship

And the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Company, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the Company at its offices in Lincoln, Nebraska, in their own persons.

The following Resolution was adopted at the Regular Meeting of the Board of Directors of the **UNIVERSAL SURETY COMPANY**, held on July 23, 1981:

"RESOLVED, That the signatures of officers of the Company and the seal of the Company may be affixed by facsimile to any Power of Attorney executed in accordance with Article V-Section 6 of the Company Bylaws: and that any such Power of Attorney bearing such facsimile signatures, including the facsimile signature of a certifying Assistant Secretary and facsimile seal shall be valid and binding upon the Company with respect to any bond, undertaking or contract of suretyship to which it is attached."

All authority hereby conferred shall remain in full force and effect until terminated by the Company.

IN WITNESS WHEREOF, **UNIVERSAL SURETY COMPANY** has caused these presents to be signed by its President and its corporate seal to be hereunto affixed this 19th day of September, 20 22.

Carol J. Clark

Secretary/Treasurer

UNIVERSAL SURETY COMPANY

By Curtis L Hartter

President

UNIVERSAL SURETY COMPANY CORPORATE SEAL LINCOLN, NEBRASKA

State of Nebraska }
County of } ss. Lancaster

On this 19th day of September, 20 22, before me personally came Curtis L. Hartter, to me known, who being by me duly sworn, did depose and say that (s)he resides in the County of Lancaster, State of Nebraska; that (s)he is the President of the **UNIVERSAL SURETY COMPANY**, the corporation described in and which executed the above instrument; that (s)he knows the seal of the said corporation; that the seal affixed to the said instrument is such corporate seal; that it was so affixed by order of the Board of Directors of said corporation; that (s)he signed (his) (her) name by like order; and that Bylaw, Article V-Section 6, adopted by the Board of Directors of said Company, referred to in the preceding instrument, is now in force.

Tara Martin

GENERAL NOTARY - State of Nebraska
TARA MARTIN
My Comm. Exp. February 16, 2026

My Commission Expires February 16, 2026.

Notary Public

I, Philip C. Abel, Director of **UNIVERSAL SURETY COMPANY**, do hereby certify that the above and foregoing is a true and correct copy of a Power of Attorney executed by said **UNIVERSAL SURETY COMPANY**, which is still in full force and effect.

Signed and sealed at the City of Lincoln, Nebraska this 31st day of May, 2023.

Philip C. Abel

Director

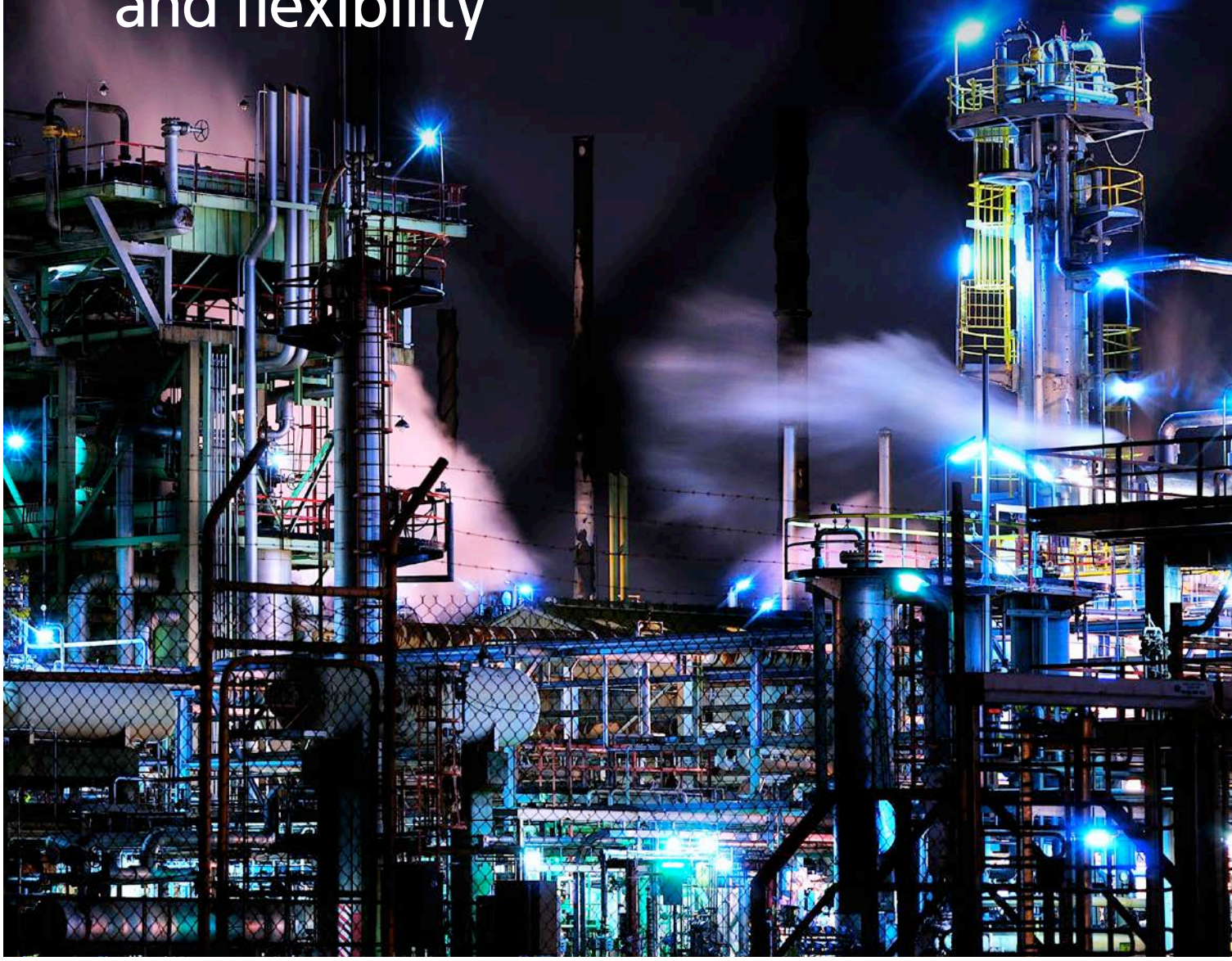
UNIVERSAL SURETY COMPANY CORPORATE SEAL LINCOLN, NEBRASKA

The Harold K. Scholz Company has been in business since 1972, is located in Ralston, NE and fabricates, installs and services power plant and substation switchgear in NE, IA, KS, MO, MN, and SD.

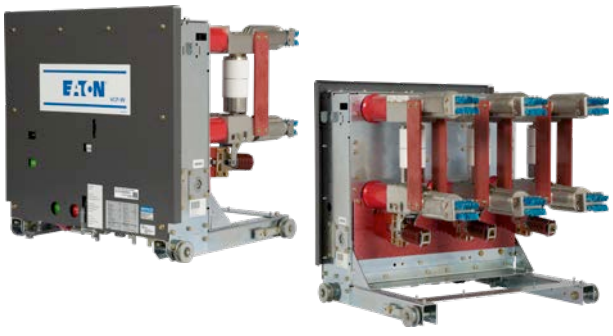
Our NE Sales Tax Exemption No: 1973215

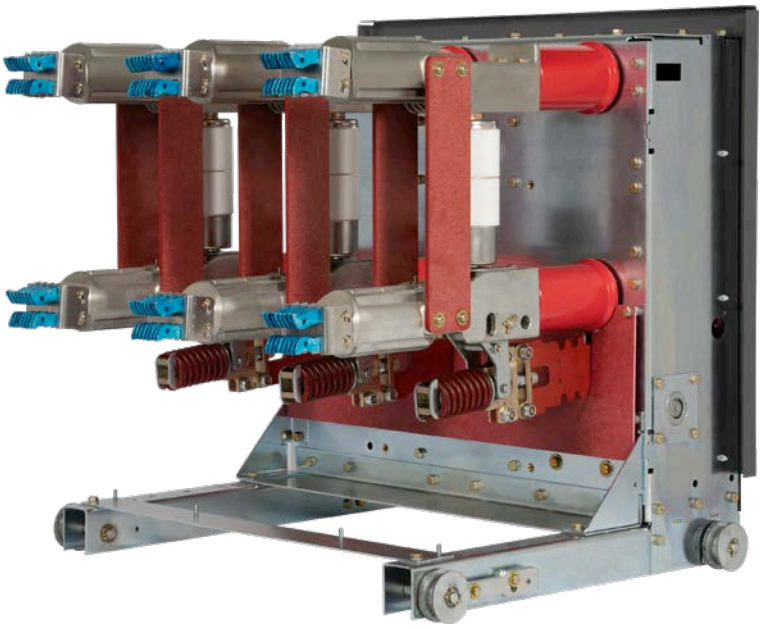
VCP-W
Medium-voltage vacuum circuit breaker

Reliable circuit protection with improved maintenance and flexibility



Powering Business Worldwide





Improved medium-voltage protection

VCP-W vacuum circuit breakers

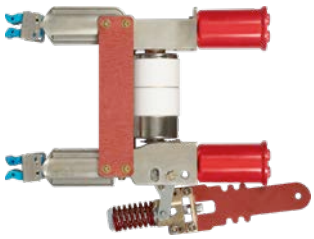
The Eaton medium-voltage VCP-W circuit breaker is renowned for its ease of handling and maintenance. This OEM-friendly product is ideal for short-circuit protection and has numerous design variations to ensure all possible applications are supported. Eaton's patented flexible conductor system features fewer moving parts, which reduces friction and wear associated with rolling/sliding designs, and increases product lifespan. The VCP-W circuit breaker is the standard in reliability, control and protection for electrical equipment and circuits.

New features

- Drop-in replacement for current VCP-W circuit breaker
- Simplified pole unit design with 89% fewer parts
- Partial discharge free
- Longer vacuum interrupter life (over 30K operations)

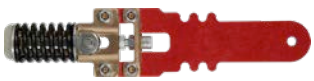
Standards

- IEEE® C37.04-2018
- IEEE C37.09-2018



Improved pole unit design

Eaton's simplified pole unit design incorporates patented conductors and has 89% fewer parts than the legacy VCP-W. The vacuum interrupters can be replaced in the field without special tooling or having to change the entire pole unit, thus reducing maintenance and labor costs.



Improved drive rod design

Eaton's adjustable drive rod design enables the quick modification of vacuum interrupter compression in the field and eliminates the need to replace pole units that exhibit low compression due to contact erosion from high mechanism operations.

Technical data

5/15 kV VCP-W vacuum circuit breaker types rated on symmetrical current rating basis, per ANSI standards

Identification	Rated values ❶❷														
				Insulation level			Short-circuit ratings (reference C37.04-2018 and C37.09-2018 except where noted)								
	Maximum voltage (V)	Nominal three-phase MVA class	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	Symmetrical interrupting current (I)	%dc component	Asymmetrical interrupting current (It)	Closing and latching current	Short-time withstand current	Interrupting time	Interrupting time (cycles at 60 Hz)	No-load (mechanical endurance)
Drawout circuit breaker type	kV rms		K	kV rms	kV peak	A rms ❸	kA rms sym	% ❹	kA rms asym total ❹	kA peak ❺	kA rms ❻	ms	Cycles ❼	❽
5VCP-W25	4.76	N/A	1	19	60	1200	25	43	29	65	25	83/50	5/3	10,000
	4.76	N/A	1	19	60	2000	25	43	29	65	25	83/50	5/3	10,000
	4.76	N/A	1	19	60	3000	25	43	29	65	25	83/50	5/3	10,000
5VCP-W32	4.76	N/A	1	19	60	1200	31.5	43	37	82	31.5	83/50	5/3	10,000
	4.76	N/A	1	19	60	2000	31.5	43	37	82	31.5	83/50	5/3	10,000
	4.76	N/A	1	19	60	3000	31.5	43	37	82	31.5	83/50	5/3	10,000
5VCP-W40	4.76	N/A	1	19	60	1200	40	43	47	104	40	83/50	5/3	10,000
	4.76	N/A	1	19	60	2000	40	43	47	104	40	83/50	5/3	10,000
	4.76	N/A	1	19	60	3000	40	43	47	104	40	83/50	5/3	10,000
5VCP-W50	4.76	N/A	1	19	60	1200	50	43	58.5	130	50	83/50	5/3	10,000
	4.76	N/A	1	19	60	2000	50	43	58.5	130	50	83/50	5/3	10,000
	4.76	N/A	1	19	60	3000	50	43	58.5	130	50	83/50	5/3	10,000
50VCP-W63 (9)	4.76	N/A	1	19	60	1200	63	55	80	164	63	83/50	5/3	10,000
	4.76	N/A	1	19	60	2000	63	55	80	164	63	83/50	5/3	10,000
	4.76	N/A	1	19	60	3000	63	55	80	164	63	83/50	5/3	10,000
8VCP-W40	8.25	N/A	1	36	95	1200	40	43	47	104	40	83/50	5/3	10,000
	8.25	N/A	1	36	95	2000	40	43	47	104	40	83/50	5/3	10,000
	8.25	N/A	1	36	95	3000	40	43	47	104	40	83/50	5/3	10,000
8VCP-W50	8.25	N/A	1	36	95	1200	50	43	58.5	130	50	83/50	5/3	10,000
	8.25	N/A	1	36	95	2000	50	43	58.5	130	50	83/50	5/3	10,000
	8.25	N/A	1	36	95	3000	50	43	58.5	130	50	83/50	5/3	10,000
15VCP-W25	15	N/A	1	36	95	1200	25	43	29	65	25	83/50	5/3	10,000
	15	N/A	1	36	95	2000	25	43	29	65	25	83/50	5/3	10,000
	15	N/A	1	36	95	3000	25	43	29	65	25	83/50	5/3	10,000
15VCP-W32	15	N/A	1	36	95	1200	31.5	43	37	82	31.5	83/50	5/3	10,000
	15	N/A	1	36	95	2000	31.5	43	37	82	31.5	83/50	5/3	10,000
	15	N/A	1	36	95	3000	31.5	43	37	82	31.5	83/50	5/3	10,000
15VCP-W40	15	N/A	1	36	95	1200	40	43	47	104	40	83/50	5/3	10,000
	15	N/A	1	36	95	2000	40	43	47	104	40	83/50	5/3	10,000
	15	N/A	1	36	95	3000	40	43	47	104	40	83/50	5/3	10,000
15VCP-W50	15	N/A	1	36	95	1200	50	43	58.5	130	50	83/50	5/3	10,000
	15	N/A	1	36	95	2000	50	43	58.5	130	50	83/50	5/3	10,000
	15	N/A	1	36	95	3000	50	43	58.5	130	50	83/50	5/3	10,000
150VCP-W63 ❾	15	N/A	1	36	95	1200	63	55	80	164	63	83/50	5/3	10,000
	15	N/A	1	36	95	2000	63	55	80	164	63	83/50	5/3	10,000
	15	N/A	1	36	95	3000	63	55	80	164	63	83/50	5/3	10,000

5/15 kV VCP-W vacuum circuit breaker types rated on symmetrical current rating basis, per ANSI standards (continued)

Identification	Rated values ❶❷													
				Insulation level			Short-circuit ratings (reference C37.04-2018 and C37.09-2018 except where noted)							
	Maximum voltage (V)	Nominal three-phase MVA class	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	Symmetrical interrupting current (I)	%dc component	Asymmetrical interrupting current (It)	Closing and latching current	Short-time withstand current	Interrupting time	Interrupting time (cycles at 60 Hz)	No-load (mechanical endurance)
Drawout circuit breaker type	kV rms		K	kV rms	kV peak	A rms ❸	kA rms sym	% ❹	kA rms asym total ❹	kA peak ❺	kA rms ❻	ms	Cycles ❼	❽
5VCP-W250	4.76	250	1	19	60	1200	36	40	41	97	36	83/50	5/3	10,000
	4.76	250	1	19	60	2000	36	40	41	97	36	83/50	5/3	10,000
	4.76	250	1	19	60	3000	36	39	41	97	36	83/50	5/3	10,000
5VCP-W350	4.76	350	1	19	60	1200	49	40	56	132	49	83/50	5/3	10,000
	4.76	350	1	19	60	2000	49	40	56	132	49	83/50	5/3	10,000
	4.76	350	1	19	60	3000	49	39	56	132	49	83/50	5/3	10,000
8VCP-W500	8.25	500	1	36	95	1200	41	40	47	108	41	83/50	5/3	10,000
	8.25	500	1	36	95	2000	41	40	47	108	41	83/50	5/3	10,000
	8.25	500	1	36	95	3000	41	39	47	111	41	83/50	5/3	10,000
15VCP-W500	15	500	1	36	95	1200	23	41	26	62	23	83/50	5/3	10,000
	15	500	1	36	95	2000	23	41	26	62	23	83/50	5/3	10,000
	15	500	1	36	95	3000	23	39	26	62	23	83/50	5/3	10,000
15VCP-W750	15	750	1	36	95	1200	36	40	41	97	36	83/50	5/3	10,000
	15	750	1	36	95	2000	36	40	41	97	36	83/50	5/3	10,000
	15	750	1	36	95	3000	36	39	41	97	36	83/50	5/3	10,000
15VCP-W1000	15	1000	1	36	95	1200	48	40	55	130	48	83/50	5/3	10,000
	15	1000	1	36	95	2000	48	40	55	130	48	83/50	5/3	10,000
	15	1000	1	36	95	3000	48	39	55	130	48	83/50	5/3	10,000

❶ All circuit breakers are tested at 60 Hz and cannot be applied at 50 Hz per C37.09-2018. If 50 Hz is required, use VCP-W Legacy breaker offering. Contact Eaton for required ratings.

❷ All breakers in this chart are UL Listed.

❸ 3000 A rated breakers can be fan-cooled for use in 4000 A rated switchgear.

❹ All breakers tested to C37.09-2018 meet the requirements for the last pole to clear during asymmetrical T100a tests defined by Table 3 of the standard, and can safely be applied at the rated asymmetrical interrupting current and %dc offset as calculated by the equations within C37.09-2018 and C37.04-2018. Ratings are based on a dc time constant of 45 ms (corresponding to X/R of 17 for 60 Hz) and determined using the circuit breaker minimum opening time plus the assumed minimum relay time of 1/2 cycle (8.33 ms for 60 Hz).

❺ These breakers were tested to (2.6 * I) for close and latch.

❻ 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 C37.04-2018 and C37.09-2018.

❼ All circuit breakers are available as 3 or 5 cycle breakers.

❽ Each operation consists of one closing plus one opening.

❾ These circuit breakers do not come with the upgraded pole units and were tested to earlier versions of the IEEE standards and can be applied at 50 Hz with no derating.

Standard features

- C2 class capacitor switch ratings
- Tin-plated pole units for resilience in harsh environment applications
- Maintenance-free Eaton vacuum interrupters with visual contact erosion indicators
- Glass polyester insulators
- Epoxy insulators (included with type VCP-WSE breakers)
- Trip-free interlocks that prevent moving a closed circuit breaker into or out of the connect position
- Provisions for manual charging of closing spring
- Operations counter
- Closing spring charged/ discharged indicator
- Circuit breaker open/closed indicator
- Spring charging motor, close coil, trip coil, latch check switch, and anti-pump relay
- Cut-out visual wipe spring indicator
- Primary and secondary fully automatic disconnects
- Ground contact finger assembly
- Auxiliary switch with 2A/3B spare contacts

Benefits

- Premium control wires and terminals provide reliable control and protection for electrical equipment and circuits, and are capable of being operated manually under full load conditions
- Front-accessible mechanism allows for easy access to the mechanism and user-friendly control components
- Unlike sliding or rolling designs, Eaton's flexible conductors have no moving parts to wear out and are maintenance-free—resulting in longer circuit breaker life
- Spiral contact design provides a self-induced magnetic effect that moves the arc root around the contact periphery, preventing hot spots and minimizing contact erosion
- Mechanically and electrically trip-free stored energy mechanism design ensures breaker contacts will not close or touch during a trip or close command; for added user safety, the closing springs will discharge automatically when the breaker is withdrawn from or inserted into its compartment

Order entry

VCP-W circuit breakers are now fully configurable with a 15-digit catalog number and will come with a QR code that can be used to view breaker-specific information online.

VCP-W circuit breakers—one of the **most trusted** medium-voltage breakers for over 50 years

We make what matters work.*

* At Eaton, we believe that power is a fundamental part of just about everything people do. Technology, transportation, energy and infrastructure—these are things the world relies on every day. That's why Eaton is dedicated to helping our customers find new ways to manage electrical, hydraulic and mechanical power more efficiently, safely and sustainably. To improve people's lives, the communities where we live and work, and the planet our future generations depend upon. Because that's what really matters. And we're here to make sure it works.

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Powering Business Worldwide

Metal-Clad Switchgear—VacClad-W—Medium Voltage Drawout Vacuum Breakers

Contents

Specifications

See Eaton's *Product Specification Guide*, available on CD or on the Web.

CSI Format:	1995	2010
	Section 16346	**Sections 26 13 26**

VacClad-W Metal-Clad Switchgear

5

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Application 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.

VacClad-W switchgear is available in maximum voltage ratings from 4.76 kV through 38 kV, and interrupting ratings as shown below. VacClad-W offers a total design concept of cell, breaker and auxiliary equipment, which can be assembled in various combinations to satisfy user application requirements. Two-high breaker arrangements are standard up to 15 kV. One-high arrangements can be furnished when required.

Ratings

Maximum Voltages:

4.76 kV, 8.25 kV, 15 kV, 27 kV, 38 kV

Interrupting Ratings:

4.76 kV: Up to 63 kA
8.25 kV: Up to 63 kA
15.0 kV: Up to 63 kA
27.0 kV: Up to 40 kA
38.0 kV: Up to 40 kA

Continuous Current—Circuit Breakers:

1200A, 2000A, 3000A (5 and 15 kV)
4000A Forced cooled (5 and 15 kV)
1200A, 2000A, (27 kV)
600A, 1200A, 1600A, 2000A, 2500A (38 kV)
3000A Forced cooled (38 kV)

Continuous Current—Main Bus:

1200A, 2000A, 3000A (5 and 15 kV)
4000A (5 and 15 kV)
1200A, 2500A (27 kV)
1200A, 2000A, 2500A, 3000A (38 kV)

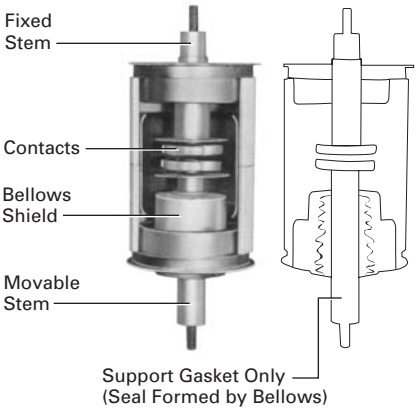
Note: Continuous currents above 4000A, contact Eaton.

Certifications

- UL and CSA listings are available

Typical Indoor Assembly with a Breaker Withdrawn on Rails

VCP-W Breaker Element



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

Advantages

Eaton's Electrical Sector has been manufacturing metal-clad switchgear for over 50 years, and vacuum circuit breakers for over 30 years. Tens of thousands of Eaton vacuum circuit breakers, used in a wide variety of applications, have been setting industry performance standards for years.

With reliability as a fundamental goal, Eaton engineers have simplified the VacClad-W switchgear design to minimize problems and gain trouble-free performance. Special attention was given to material quality and maximum possible use was made of components proven over the years in Eaton switchgear.

Maintenance requirements are minimized by the use of enclosed long-life vacuum interrupters. When maintenance or inspection is required, the component arrangements and drawers allow easy access. VacClad-W's light weight simplifies handling and relocation of the breakers.

Standards

Eaton's VacClad-W switchgear meets or exceeds ANSI/ IEEE C37.20.2 and NEMA® SG-5 as they apply to metal-clad switchgear. The assemblies also conform to Canadian standard CSA®-C22.2 No. 31-04, and EEMAC G8-3.2. Type VCP-W vacuum circuit breakers meet or exceed all ANSI and IEEE standards applicable to AC high voltage circuit breakers rated on symmetrical current basis.

Seismic Qualification

Refer to **Tab 1** for information on seismic qualification for this and other Eaton products.

Metal-Clad Switchgear Compartmentalization

Medium voltage metal-clad switchgear equipment conforming to C37.20.2 is a compartmentalized design, wherein primary conductors are fully insulated for the rated maximum voltage of the assembly, and all major primary circuit components are isolated from each other by grounded metal barriers. This type of construction minimizes the likelihood of arcing faults within the equipment and propagation of fault between the compartments containing major primary circuits.

The C37.20.2 metal-clad switchgear equipment is designed to withstand the effects of short-circuit current in a bolted fault occurring immediately downstream from the load terminals of the switchgear. The bolted fault capability is verified by short-time and momentary short-circuit withstand current testing on complete switchgear, as well as by fault making (close and latch) testing on the switching devices as shown in **Figure 5.1-1**.

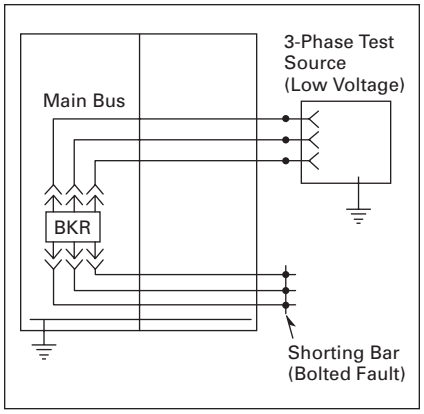


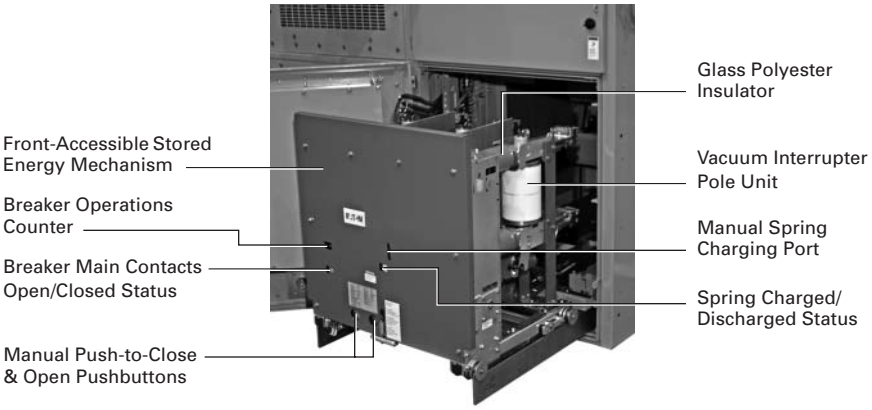
Figure 5.1-1. Metal-Clad Switchgear Short-Circuit and Momentary Withstand Tests

The short-time current withstand tests demonstrate electrical adequacy of busses and connections against physical damage while carrying the short-circuit current for a given duration. The momentary current withstand tests demonstrate the mechanical adequacy of the structure, busses and connections to withstand electro-magnetic forces with no breakage of insulation. It should be noted that design testing of standard metal-clad switchgear does not involve any internal arcing faults.

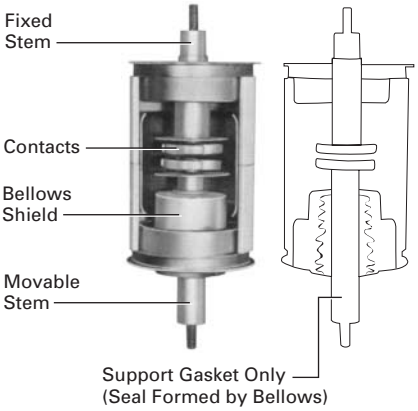
Features—Vacuum Circuit Breaker

- High power laboratory tests prove VCP-W breakers are capable of 50 to 200 full fault current interruptions
- V-Flex (stiff-flexible) current transfer from the vacuum interrupter moving stem to the breaker primary disconnecting contact is a non-sliding/non-rolling design, which eliminates maintenance required with the sliding/rolling type transfer arrangements. The V-Flex system provides excellent electrical and thermal transfer, and long vacuum interrupter life.
- Easy inspection and accessibility is afforded by a front-mounted stored energy operating mechanism. The same basic mechanism is used on all ratings, which requires a minimum investment in spare parts
- All VCP-W circuit breakers are horizontal drawout design, which provides connect, test and disconnect position. A latch secures the breaker in the connected and disconnected/ test position. 5/15/27 kV breakers can be fully withdrawn on extension rails for inspection and maintenance without the need for a separate lifting device. 38 kV circuit breaker is designed to roll directly on the floor
- All breaker functions, indicators and controls are grouped on an easily accessible panel on front of the breaker
- Trip-free interlocks prevent moving a closed circuit breaker into or out of the connected position
- Breaker cannot be electrically or mechanically closed when in the intermediate position
- Closing springs automatically discharge before moving the circuit breaker into or out of the enclosure
- Breaker frame remains grounded during levering and in the connected position
- Coding plates are provided to ensure only correct breaker rating can be installed in cell
- Quality Assurance Certificate is included with each circuit breaker
- Easy-to-see contact erosion indicator is provided as standard on the vacuum interrupter moving stem. Only periodic visual inspection is required to verify that the contacts have not worn out
- A simple visual means, T-cutout, is provided to verify by simple visual inspection that the loading springs are applying proper pressure to the contacts when the breaker is closed
- Corona-free design increases circuit breaker reliability and in-service life by maintaining insulation integrity
- Vacuum interrupters with copper-chrome contacts provide superior dielectric strength and very low chop current
- High-strength, high-impact, track-resistant glass polyester on 5/15 kV and cycloaliphatic epoxy on 27/38 kV is used for primary insulation and support as standard

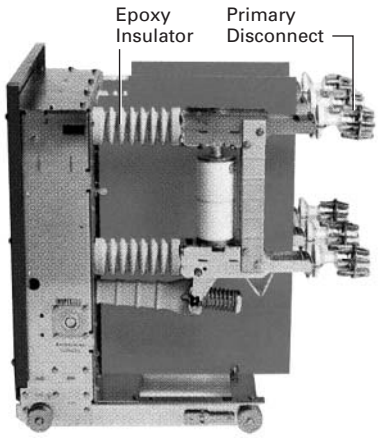
Type VCP-W Vacuum Circuit Breakers



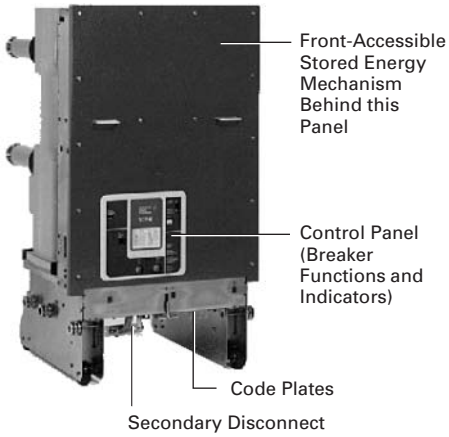
Type VCP-W 5/15 kV Circuit Breaker



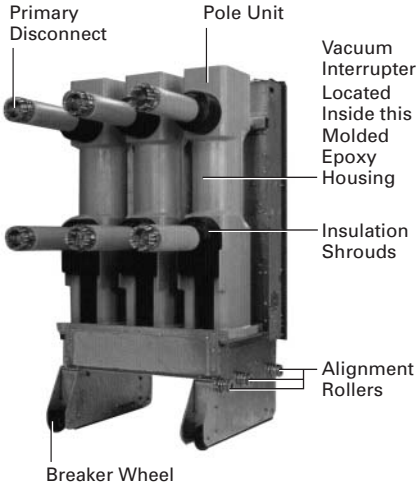
Cut-away View of Vacuum Interrupter (Enlarged to Show Detail)



Type VCP-W 27 kV Circuit Breaker—Side View



Type VCP-W 38 kV Circuit Breaker—Front View

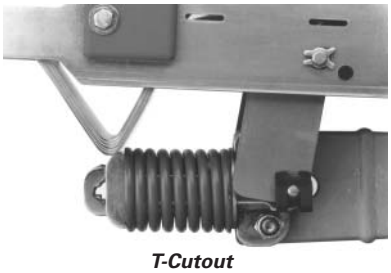


Type VCP-W 38 kV Circuit Breaker—Rear View

Type VCP-W Circuit Breaker—Features

V-Flex System

Contact Erosion Indicator



T-Cutout

Features—Switchgear Assembly

VacClad is a Metal-Clad Design

Eaton's VacClad switchgear is an integrated assembly of drawout vacuum circuit breakers, bus and control devices coordinated electrically and mechanically for medium voltage circuit protection and control. The metal-clad integrity provides maximum circuit separation and safety.

- All circuit breakers are equipped with self-aligning and self-coupling primary and secondary disconnecting devices, and arranged with a mechanism for moving it physically between connected and disconnected positions
- All major primary components, such as circuit breaker, voltage transformer, control power transformer, and buses are completely enclosed and grounded by metal barriers. A metal barrier in front of the circuit breaker and auxiliary drawer ensures that, when in the connected position, no live parts are exposed by opening the compartment door
- Automatic shutters cover primary circuit elements when the removable element is in the disconnected, test or removed position
- All primary bus conductors and connections are insulated with track-resistant fluidized bed epoxy coating for rated maximum voltage of the assembly
- Mechanical interlocks are provided to maintain a proper and safe operating sequence
- Instruments, meters, relays, secondary control devices and their wiring are isolated, where necessary, by grounded metal barriers from all primary circuit elements

VacClad is Corona Free

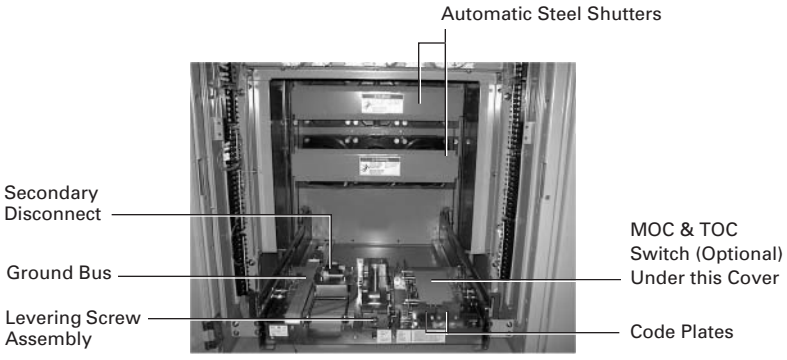
Corona emissions within the standard VacClad switchgear assemblies have been eliminated or reduced to very low levels by special fabrication and assembly techniques, such as rounding and buffing of all sharp copper edges at the joints, employing star washers for bolting metal barriers, and using specially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

Circuit Breaker Compartment

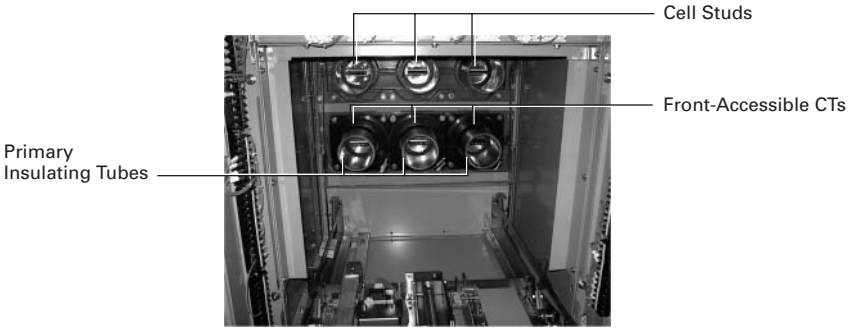
- The mechanism for levering the breaker is a unique cell mounted design. It incorporates all the safety interlocks to render the breaker mechanically and electrically trip-free during the levering procedure
- A silver-plated copper ground bus provided on the levering pan assembly is engaged by a spring loaded ground contact on the circuit breaker to ensure that the circuit breaker remains grounded throughout its travel

Type VCP-W Metal-Clad Switchgear Assembly (5/15 kV Shown)

Front View



Circuit Breaker Compartment



Circuit Breaker Compartment Shown with Shutters Opened for Illustration

Circuit Breaker Compartment (Continued)

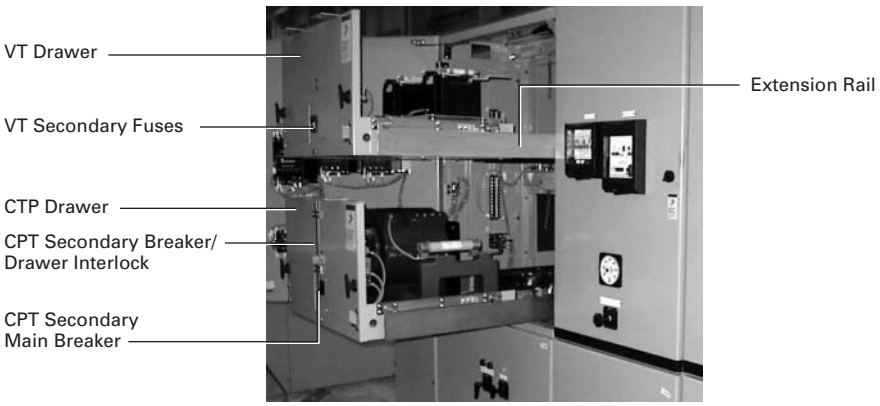
- Each circuit breaker compartment is provided with steel shutters (breaker driven) that automatically rotate into position to cover the insulating tubes and stationary cell studs to prevent accidental contact with live primary voltage, when the breaker is withdrawn from the connected position
- Current transformers installed over the primary insulating tubes, located behind the steel shutters, are front accessible. Up to four standard accuracy current transformers can be installed per phase. Front accessibility permits adding or changing the transformers when the unit is de-energized without breaking high voltage connections and primary insulation
- Code plates ensure that only correct breaker rating can be installed in cell
- Control power transformer drawer is mechanically interlocked with the transformer secondary main breaker that requires the main breaker to be opened, so that the primary circuit is disconnected only under no-load when the drawer is withdrawn
- Grounding straps are provided in each drawer to automatically ground and discharge primary fuses when the drawer is withdrawn

Auxiliary Compartments

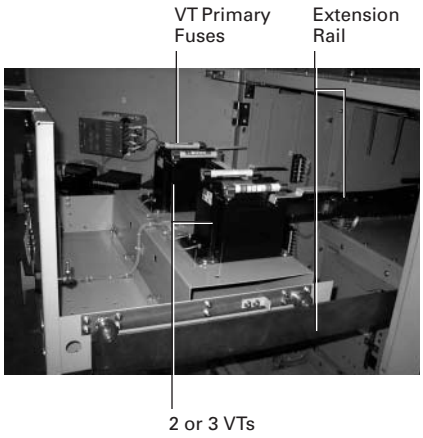
5/15 kV VacClad design permits up to four auxiliary drawers in one vertical unit (only two shown in the photo). These drawers can be used for installing voltage or control power transformers, or primary fuses. Each drawer can also be configured for use as a battery tray.

- Each auxiliary drawer is a horizontal drawout design that can be fully withdrawn on extension rails similar to the breaker, thus allowing front access to auxiliary equipment to permit easy testing and fuse replacement
- A safety shutter (operated by the drawer) is included in each auxiliary drawer compartment. It automatically operates when the auxiliary drawer is withdrawn to protect workmen from accidental contact with the stationary primary contacts
- Each auxiliary drawer can accommodate two voltage transformers, connected line-to-line (open delta); three voltage transformers, connected line-to-ground; or single-phase control power transformer up to 15 kVA, 15 kV with their associated primary fuses. Three-phase control power transformer, or single-phase transformers larger than 15 kVA can be fixed mounted within the structure, with their primary fuses installed in the auxiliary drawer

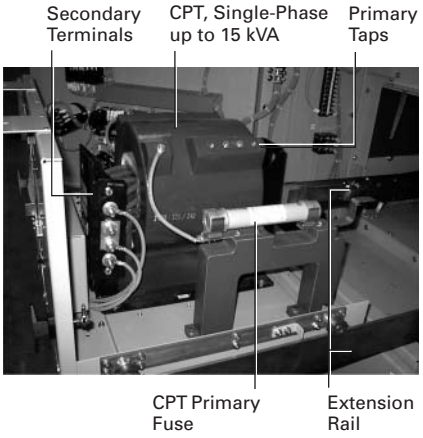
Type VCP-W Metal-Clad Switchgear Assembly (5/15 kV Shown)



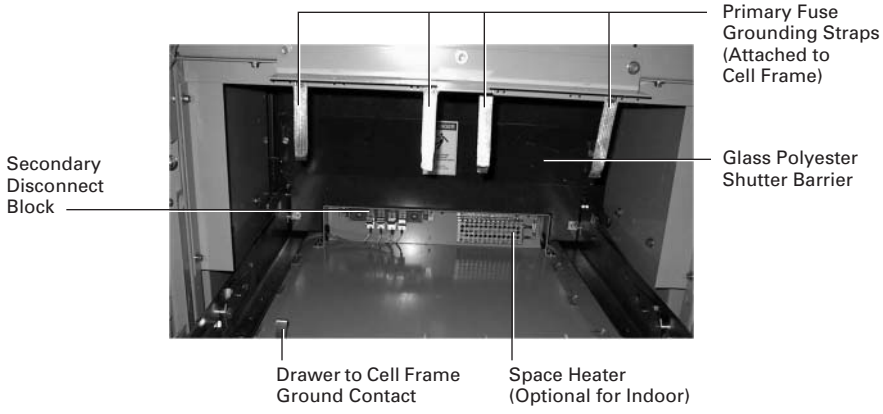
Drawout Auxiliaries



VT Drawer Shown Fully Withdrawn on Rails



CPT Drawer Shown Fully Withdrawn on Rails



VT/CPT Compartment with VT/CPT Drawer Removed—Inside View

5

Rear Compartments

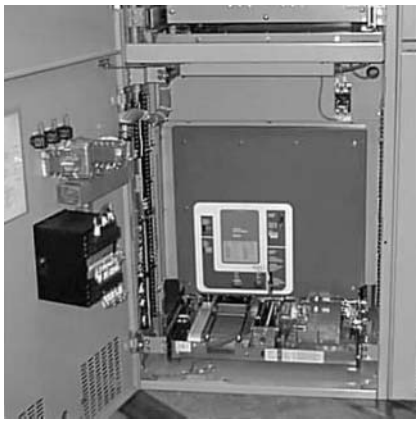
Rear of each structure is segregated into main bus and cable compartments by grounded metal barriers, as required for a given application. Access to main bus and power cable connections is provided from the rear through removable bolted covers or optional rear hinged doors. Cable trough (chimney) is provided to segregate upper and lower compartment power cables as required.

- All primary buses (main bus and line and load runbacks) are 100% conductivity copper, and insulated for rated maximum voltage of the assembly by flame retardant, track-resistant fluidized epoxy coating. The bolted bus joints are silver- or optionally tin-plated for positive contact and low resistance, with each joint insulated with easily installed boots. Bus supports between the adjacent units are made of high-impact, high-strength, track-resistant glass polyester at 5 and 15 kV, and cycloaliphatic epoxy at 27 and 38 kV
- Adequate space is available for cable termination, bus duct connection, installation of zero sequence current transformers, and surge arresters. In two-high arrangement, power cables for each circuit are separated by metal barriers
- A bare copper ground bus is provided in the rear of each structure, which extend the entire length of the switchgear
- All control wiring is isolated from primary circuit elements by grounded metal-conduit or braided metal jacket, with the exception of short lengths of wire such as at instrument transformer terminals

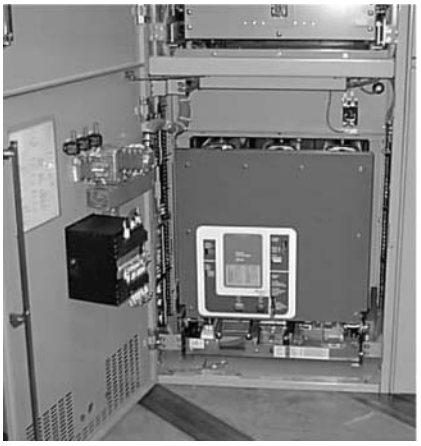
5

Type VCP-W Metal-Clad Switchgear Assembly (5/15 kV Shown)

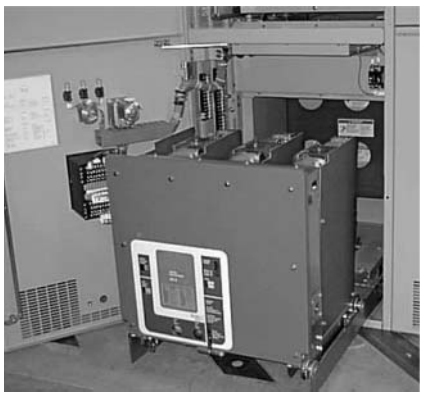
Rear View



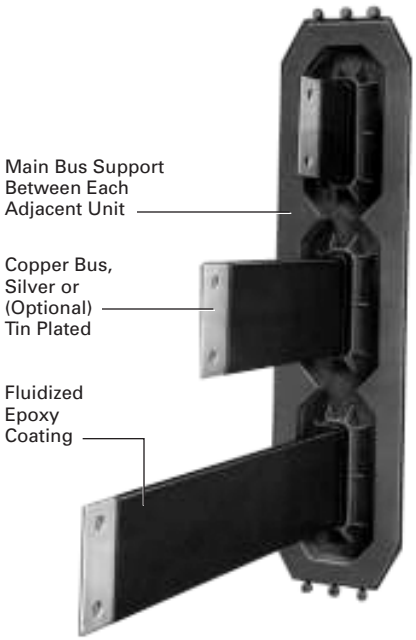
Breaker Shown in the Connected Position



Breaker Shown in the Test/ Disconnected Position



Breaker Shown in the Fully Withdrawn Position



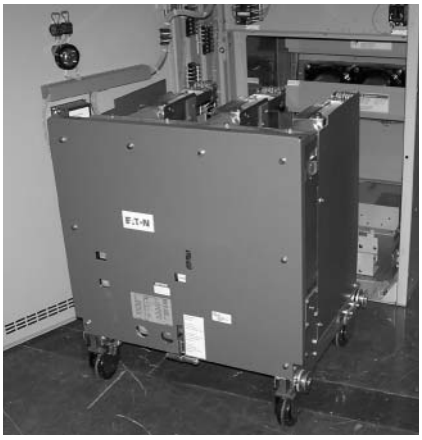
Main Bus Details

Roll-on-the-Floor Breaker Option

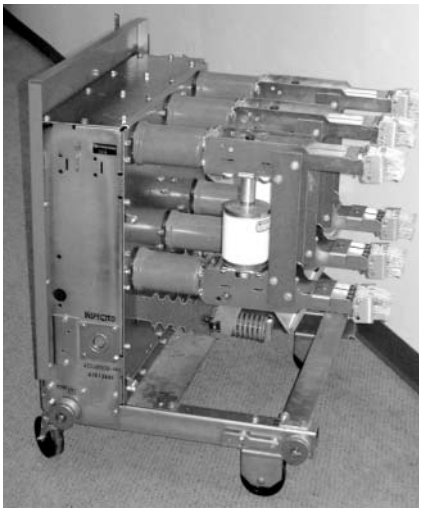
Roll-on-the-Floor Switchgear Compartment

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 2000A 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 3000A circuit breaker in the lower compartment, the compartment above the breaker is left blank for ventilation. The design is rated for application in Seismic Zone 4 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

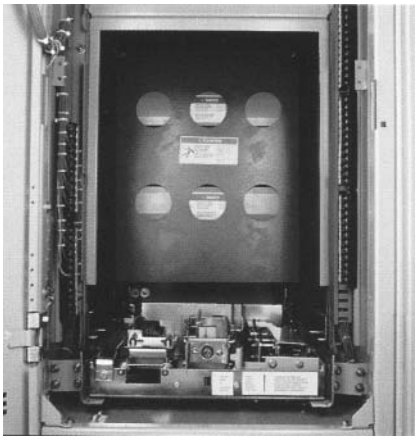


VCP-W Direct Roll-in Breaker with Swivel Wheels on Front

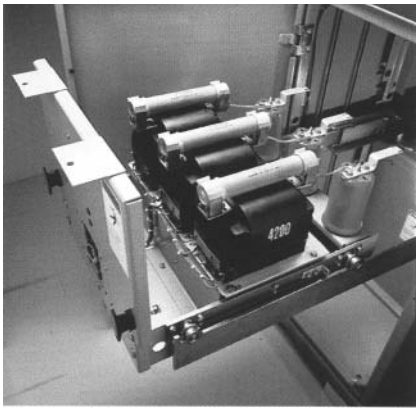
5

26.00-Inch (660.4 mm) Wide 5 kV 250 MVA Switchgear

Fully Withdrawn Breaker



Automatic Shutters



Fused PT Drawer

Application Description

This narrow width VacClad-W MV Metal-Clad switchgear was designed for use in instances where floor space requirements would not allow the industry standard 36.00-inch (914.4 mm) wide switchgear. Typical applications include not only new construction but also replacement switchgear for installations previously equipped with 26.00-inch (660.4 mm) wide air-break devices. This line of switchgear has also been used where 5 kV, 1200A, 250 MVA applications are commonplace, such as generator and control applications.

Ratings

The 26.00-inch (660.4 mm) wide switchgear line is designed for use with Eaton's Type VCPW-ND *"Narrow Design"* vacuum circuit breakers rated 4.76 kV, 60 kV BIL, 250 MVA, 1200A maximum, with rated main bus of 1200 or 2000A. For installations requiring 2000A main breakers with 1200A feeders, lineups can be built with standard 36.00-inch (914.4 mm) wide main breaker cubicles and 26.00-inch (660.4 mm) wide feeders.

Configurations

26.00-Inch (660.4 mm) Wide Standard Model

The 26.00-inch (660.4 mm) wide design is flexible. Available configurations include breaker over breaker, one or two auxiliary drawers over breaker, breaker over one or two auxiliary drawers, or up to four auxiliary drawers in one vertical section. The standard height and depth are 95.00-inch (2413.0 mm) and 96.25-inch (2444.8 mm) respectively. A breaker over auxiliary, or auxiliary over breaker combination can be supplied in reduced depth of 86.25-inch (2190.8 mm). The depth of breaker over breaker combination can also be reduced to 86.25-inch (2190.8 mm) if power cables for top breaker enter from the top and the cables for bottom breaker enter from the bottom.

The main bus location and connections in the standard 95.00-inch (2413.0 mm) high 26.00-inch (660.4 mm) wide design are 100% compatible with standard 95.00-inch (2413.0 mm) high 36.00-inch (914.4 mm) wide vertical sections. As a result, additions to existing Eaton 5 kV, 250 MVA 36.00-inch (914.4 mm) wide VCP-W installations can be simply and rapidly performed without costly system modifications and transition sections. Refer to **Pages 5.5-7** and **5.5-8** for available configurations, dimensions and weights.

26.00-Inch (660.4 mm) Wide Low Profile Model

In addition to the floor space saving offered by the standard 26.00-inch (660.4 mm) wide model, a further saving in the height and depth of the switchgear is also available. Where height and depths are an issue, such as an outdoor powerhouse or in a mobile power container, the standard 95.00-inch (2413.0 mm) high unit can be reduced to an 80.00-inch high (2032.0 mm), 72.00-inch (1828.9 mm) deep low profile model. Main bus rating available in the 80.00-inch (2032.0 mm) high x 72.00-inch (1828.9 mm) deep low profile model is limited to 1200A maximum. It is not compatible in size or location with standard 26.00-inch (660.4 mm) wide or 36.00-inch (914.4 mm) wide, 95.00-inch (2413.0 mm) high VCP-W units.

The low profile model is designed to house breaker over auxiliary or auxiliary over breaker, or auxiliary over auxiliary. In order to provide maximum vertical space for power cable terminations, auxiliary over breaker configuration should be used for customer's top entrance cables, and breaker over auxiliary configuration should be used for customer's bottom entrance cables. Auxiliary compartments are designed to accommodate one or two auxiliary drawers. That is, up to four auxiliary drawers can be installed in an auxiliary over auxiliary configuration. A set of two line-to-line or three line-to-ground connected voltage transformers, or a single-phase control power transformer up to 15 kVA can be installed in each auxiliary drawer. Because of the reduced depth, control devices cannot be located on breaker compartment door. All control devices should be located on the auxiliary compartment doors. Refer to **Pages 5.5-9** for available configurations, dimensions and weights.

For all 26.00-inch (660.4 mm) wide configurations, multifunction microprocessor-based relays and meters, such as Eaton's Digitrip® 3000 and IQ meters are recommended for reduced panel space.

27 kV Metal-Clad Switchgear

Application Description

Eaton's 27 kV nominal metal-clad switchgear is used for applications at system voltages higher than 15 kV, up to and including 27 kV. It is designed for use with Type VCP-W, horizontal drawout vacuum circuit breakers.

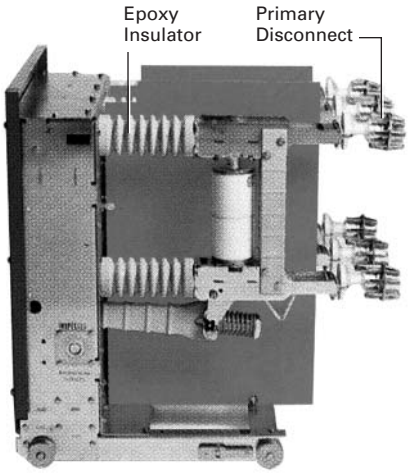
Ratings

- Maximum rated voltage: 27 kV rms
  Note: Eaton tested to 28.5 kV.
- BIL withstand: 125 kV peak
- Maximum symmetrical interrupting: 16 kA, 22 kA, 25 kA, 40 kA rms
- Continuous current:
  Circuit breakers—1200A, 2000A
  Switchgear main bus—
  One-high design: 1200A, 2000A
  Two-high design: 1200A, 2000A, 2500A, 2700A

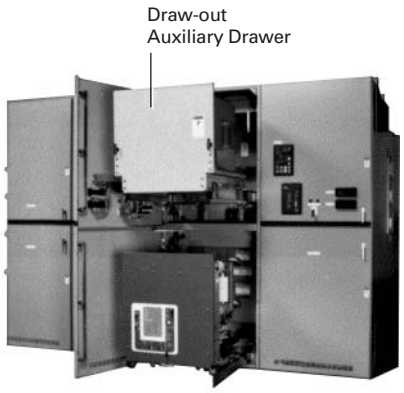
Features and Configurations

27 kV metal-clad switchgear design is an extension of Eaton's 5 and 15 kV VacClad design. It has same footprint and overall space envelop, and it incorporates all features and advantages of the 5 and 15 kV VacClad design, with the exception of some modifications required for 27 kV application.

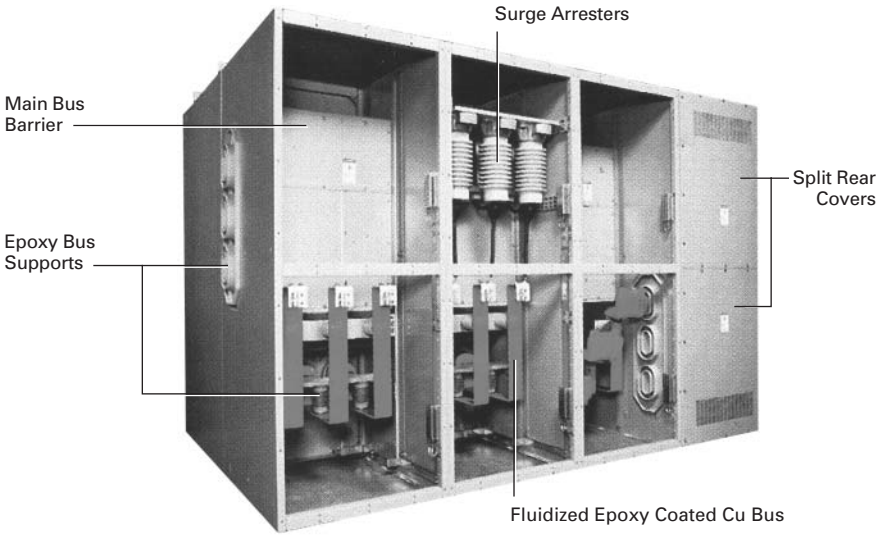
- Uses horizontal drawout type VCP-W 125 kV BIL rated vacuum circuit breakers
- A cycloaliphatic epoxy insulation material is used throughout the switchgear housings and the circuit breakers for phase-to-ground and phase-to-phase primary bus supports. For decades, cycloaliphatic epoxy insulation has demonstrated its outstanding electrical and mechanical characteristics in harsh outdoor applications. The use of this insulation system with the 27 kV design ensures a comfortable margin of safety at higher voltages
- All primary bus conductors are insulated for full 28.5 kV by fluidized epoxy coating. All buses are fabricated from 100% conductivity copper. Bus joints are silver- or tin-plated as required, and covered with pre-formed insulating boots to maintain metal-clad integrity
- Available configurations include: auxiliary over breaker, and auxiliary over auxiliary. Each auxiliary or breaker requires one-half vertical space
- Each auxiliary drawer can accommodate two voltage transformers connected line-to-line, or three voltage transformers connected line-to-ground, which can be withdrawn for easy maintenance and replacement of primary fuses
- When required by an application, a single-phase control power transformer up to 37.5 kVA, or a three-phase control power transformer up to 75 kVA can be fixed mounted in the front bottom compartment, with the primary fuses in an auxiliary drawer located in the upper compartment. When the control power transformer is located remotely from the switchgear, but fed through primary fuses located in the switchgear, the fuses are installed in an auxiliary drawer. The primary fuse drawer is key interlocked with the control power transformer secondary main breaker to ensure that it is opened first, and transformer load is disconnected, before the fuse drawer can be withdrawn
- 27 kV metal-clad switchgear is available in general purpose, ventilated, indoor or outdoor aisleless type enclosure
- Two-high 27 kV arrangements with breaker-over-breaker are available in indoor type enclosure
- **Roll-on-the-floor configurations are available**



27 kV VCP-W Circuit Breaker—Side View



27 kV Switchgear—Front View



27 kV Switchgear—Rear View

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38 kV Metal-Clad Switchgear

Application Description

Eaton's VacClad switchgear family is designed for use in applications with distribution voltages up to 38 kV maximum. Typical applications include not only new construction but also replacement for older air-break, minimum oil or SF6 switchgear. The circuit breaker and switchgear will meet industry requirements for greater safety, quality, superior reliability and minimal maintenance while providing higher insulation levels in less space than other breaker types, thus reducing overall switchgear size for significant space savings.

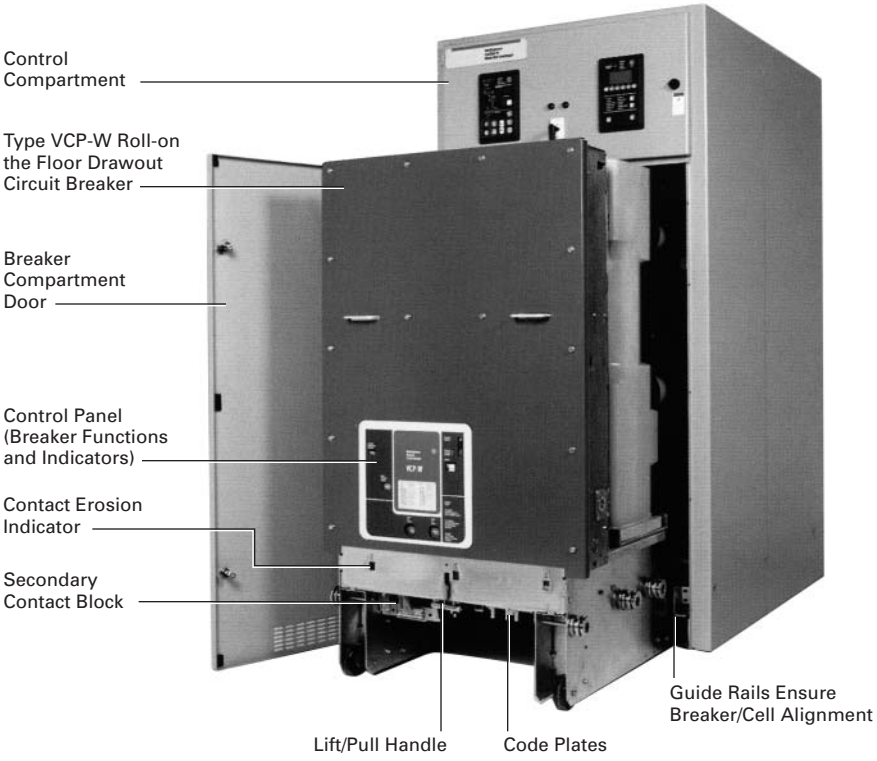
5

Ratings

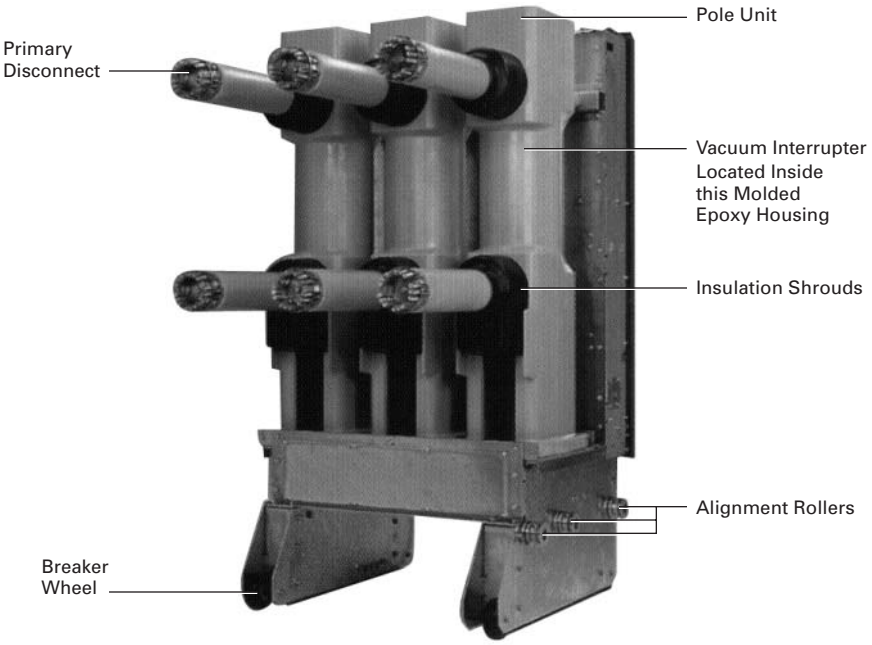
- Maximum rated voltage: 38 kV rms
- BIL withstand: 150 and 170 kV peak
- Maximum symmetrical interrupting with K = 1: 16 kA, 25 kA, 31.5 kA, 40 kA rms, and 35 kA rms (21 kA rating with K = 1.65)
- Continuous current:
  Circuit breakers—up to 2500A
  Switchgear main bus—up to 3000A

Features—38 kV Vacuum Circuit Breaker

- Corona-free design increases circuit breaker reliability and in-service life by maintaining insulation integrity
- Superior cycloaliphatic epoxy insulation—a void-free insulating material with outstanding electrical and mechanical characteristics, such as track resistance, dielectric strength, and fungus resistance, even in harsh industrial environment—is used throughout the circuit breaker as primary phase-to-phase and phase-to-ground insulation
- Axial-magnetic, copper-chrome contacts are used in 38 kV vacuum interrupters to provide superior dielectric strength, better performance characteristics, and lower chop current
- High power laboratory tests prove VCP-W breakers are capable of 50 to 200 full fault current interruptions
- V-Flex (stiff-flexible) current transfer from the vacuum interrupter moving stem to the breaker primary disconnecting contact is a non-sliding/non-rolling design, which eliminates maintenance required with the sliding/rolling type transfer arrangements. The V-Flex system provides excellent electrical and thermal transfer, and long vacuum interrupter life
- Easy inspection and accessibility is afforded by front mounted stored energy operating mechanism. The same basic mechanism is used on all ratings, which requires a minimum investment in spare parts
- All 38 kV circuit breakers are horizontal drawout design, which provide connect, test and disconnect position. A latch secures the breaker in the connected and disconnected/test position. The circuit breaker is designed to roll directly on the floor



38 kV Breaker—Fully Withdrawn



38 kV Breaker—Rear View

Features—38 kV Vacuum Circuit Breaker (Continued)

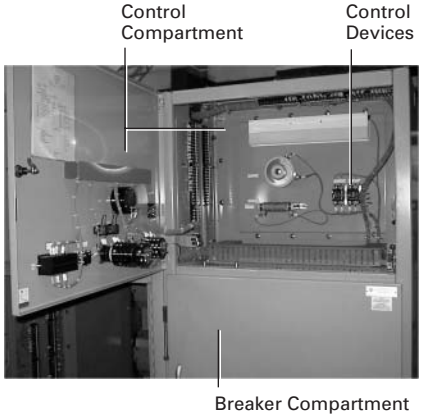
- All breaker controls and indicators are functionally grouped on the front control panel and include: main contact status, closing spring status, port for manual spring charging, close and trip button, and mechanical operations counter
- Clearly visible contact erosion indicator on the front of the breaker
- Trip-free interlocks prevent moving a closed circuit breaker into or out of the connected position
- Breaker cannot be electrically or mechanically closed when in the intermediate position
- Closing springs automatically discharge before moving the circuit breaker into or out of the enclosure
- Breaker frame remains grounded during levering and in the connected position
- Coding plates are provided to ensure only correct breaker rating can be installed in cell
- Quality Assurance Certificate is included with each circuit breaker

38 kV Switchgear—Circuit Breaker Compartment

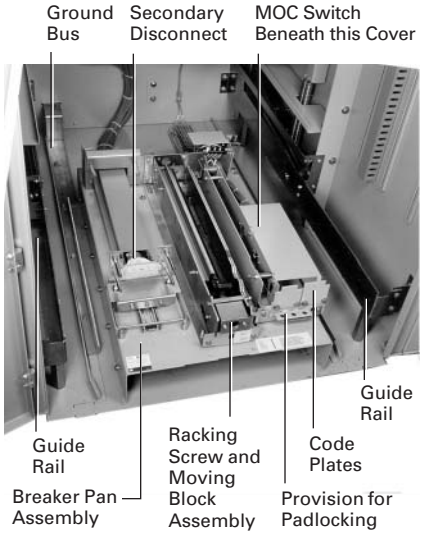
Features—38 kV Switchgear Assembly

Like the circuit breaker described above, the 38 kV switchgear assembly is a corona-free metal-clad design. It incorporates many features and advantages of 5, 15 and 27 kV VacClad design, with additional modifications required for 38 kV application.

- Industry-leading cycloaliphatic epoxy supports are used for primary phase-to-phase and phase-to-ground insulation throughout, providing 170 kV BIL and 80 kV (1 minute) power frequency withstand capability
- All primary bus conductors are insulated for full 38 kV by fluidized epoxy coating. All buses are fabricated from 100% conductivity copper. Bus joints are silver- or tin-plated as required, and covered with Eaton's pre-formed insulating boots to maintain metal-clad integrity

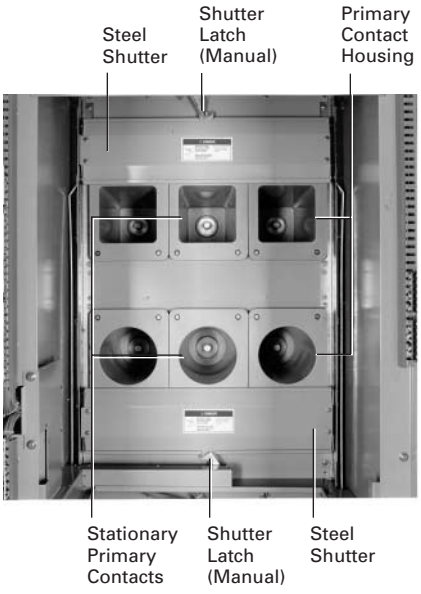


38 kV Switchgear—Control Compartment



Breaker Levering Pan Assembly

- Circuit breaker compartment is designed to interface with Type VCP-W 38 kV circuit breaker. It includes floor-mounted breaker pan assembly (levering assembly) with all safety interlocks required by the metal-clad design. Cell mounted guide rails accurately guide the breaker into the cell during levering, and ensure correct alignment of the circuit breaker primary disconnects with the cell primary contacts when breaker reaches connected position
- Coding plates are provided to ensure only correct breaker rating can be installed in the cell
- Automatic steel shutters cover cell primary contacts when circuit breaker is withdrawn from its connected position, to prevent persons from accidentally touching the stationary primary cell contacts. Each shutter can be padlocked in the closed or open position. It can also be manually latched open as required for maintenance



Breaker Compartment (Shutter Shown Open for Illustration)

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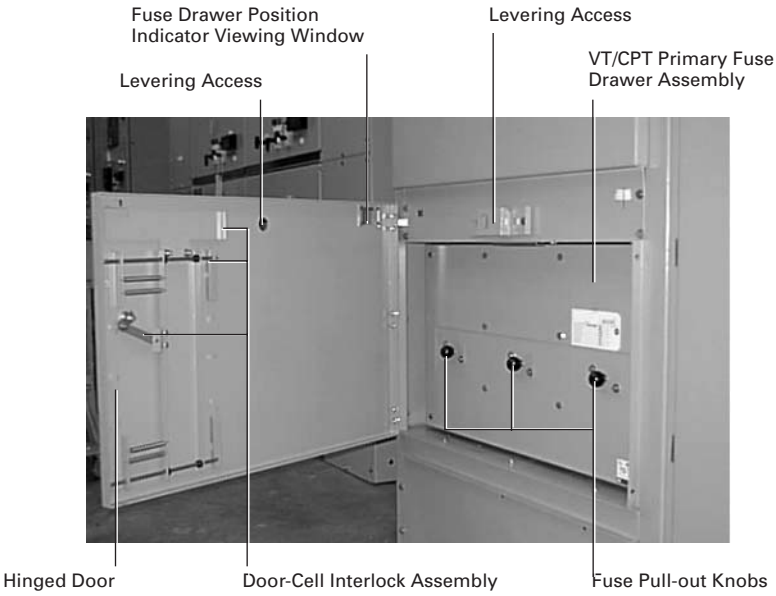
Features—38 kV Switchgear Assembly (Continued)



VT/CPT Primary Fuse Drawer (Shown with Door Open)

- A separate control compartment is provided for installation of protection, metering and control devices. No devices are located on circuit breaker compartment door
- Rear of the switchgear is divided in main bus and cable compartments, isolated from each other by grounded metal barriers. Sufficient space is available for customer's top or bottom entry power cables. Bus duct terminations can also be supplied. A bare copper ground bus is provided along the entire lineup, with an extension in each cable compartment for termination of power cable shields

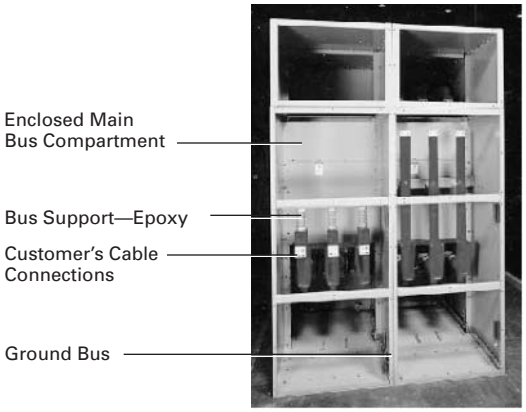
38 kV, 170 kV BIL Design

- Line side current transformer bushings are included as standard. Bus side current transformer bushings are only included when bus side current transformers are supplied
- Ring-type current transformers are installed over bus or line side primary insulating bushings as required. They are accessible from the rear of the unit. Maximum two sets of standard accuracy or one set of high accuracy current transformers can be installed on the bus side; and three sets of standard accuracy or one set of standard, and one set of high accuracy transformers can be installed on the line side
- Voltage and control power transformers (VTs and CPTs), when required, are stationary mounted inside the cubicle, with their primary fuses installed in a drawout auxiliary drawer
- Each primary fuse drawer is provided with a levering mechanism for moving the drawer within its compartment between connected and disconnected positions, with the compartment door closed. The levering mechanism is mechanically interlocked with the compartment door such that the door cannot be opened, and access to the primary fuses cannot be gained, until the drawer is levered out to the disconnected position. A colored flag visible through a small viewing window on the compartment door indicates the position of the drawer inside the compartment as follows:
  - Red Color—drawer is in the fully connected position
  - Green Color—drawer is in the fully disconnected position
  - Orange Color—drawer is in-between connected and disconnected position
- Also provided are grounding straps to automatically discharge the fuses as they are pulled from the fuse holders
- On VT fuse drawers, a cell switch automatically disconnects the secondary circuit before the primary fuses are disconnected as the drawer is withdrawn
- On CPT fuse drawers, the compartment door is key interlocked with the CPT main secondary circuit breaker such that the access to the drawer levering mechanism is blocked until the secondary main breaker is opened

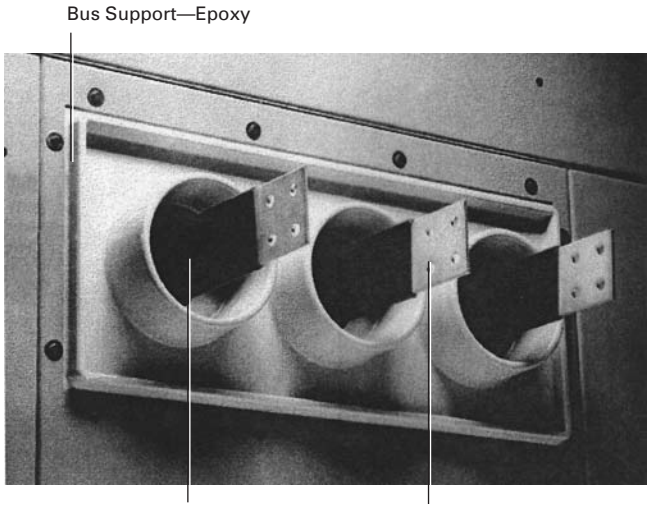
38 kV, 150 kV BIL Design

- This design is similar to 38 kV, 170 kV BIL design described previously, except main bus is oriented differently and the design is provided with drawout VT with integral fuses, and front accessible CTs. Each 38 kV 150 kV BIL indoor structure is 42.00-inch (1066.8 mm) wide x 95.00-inch (2413 mm) high x 124.36-inch (3158.8 mm) deep. The 150 kV BIL assembly uses the same 38 kV circuit breakers as in 170 kV BIL assemblies. The breakers are interchangeable between the two designs
- Voltage transformers are equipped with integral top-mounted primary fuses and installed in an auxiliary compartment. Two auxiliary compartments can be provided in one vertical section. Each auxiliary compartment can be supplied with 1, 2 or 3 VTs, and can be connected to bus or line, as required for a given application. The VTs assembly is located behind a fixed bolted panel, and provided with mechanism for moving it between connected and disconnected position. The VT assembly is interlocked with the fixed bolted panel such that the panel cannot be removed unless the VTs are withdrawn to disconnected position. A shutter assembly covers the primary stabs when VTs are withdrawn to disconnected position. A mechanism is also provided to automatically discharge VT primary fuses as the VTs are withdrawn from connected to disconnected position
- Ring type current transformers are installed over bus or line side primary insulating bushings, located behind the steel shutters, in the breaker compartment. In this design, the CTs are easily accessible from the front, after removal of the circuit breaker. The front accessibility permits adding or changing the CTs when the equipment is de-energized, but without removal of high voltage joints or primary insulation. The design allows installations of two sets of standard or one set of high accuracy CTs on each side of the circuit breaker
- As of this update, the 38 kV, 150 kV BIL design cannot be supplied for applications that require a CPT, or primary fuse drawer for a remote CPT. Contact Eaton for availability

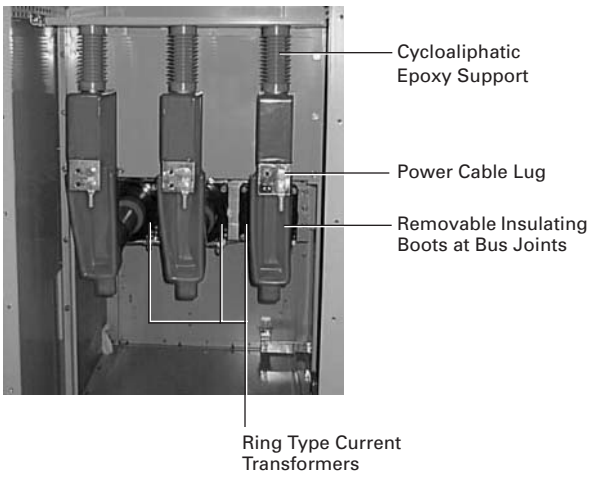
Features—38 kV Switchgear Assembly (Continued)



38 kV Switchgear Assembly—Rear View



Main Bus



Rear Compartment (Partial)

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Arc-Resistant Metal-Clad Switchgear Medium Voltage

Arc-Resistant Switchgear with Plenum Installed

Application Description

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.

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 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 as noted on **Page 5.1-2**. 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 5.2-1**.

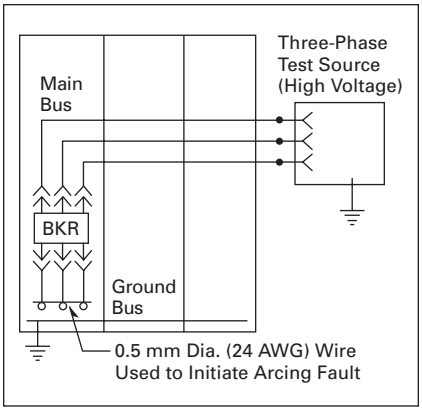


Figure 5.2-1. Arc-Resistant Switchgear Enclosure Internal Arcing Short-Circuit Withstand Test

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.

5

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 **Tables 5.4-1B**, **5.4-2** and **5.4-3** 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 overpressure, 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 all normal functions with the door closed and latched, with no exposure to potential arc flash. Those functions include: Breaker levering, manual charging of closing springs, manual opening and closing 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.

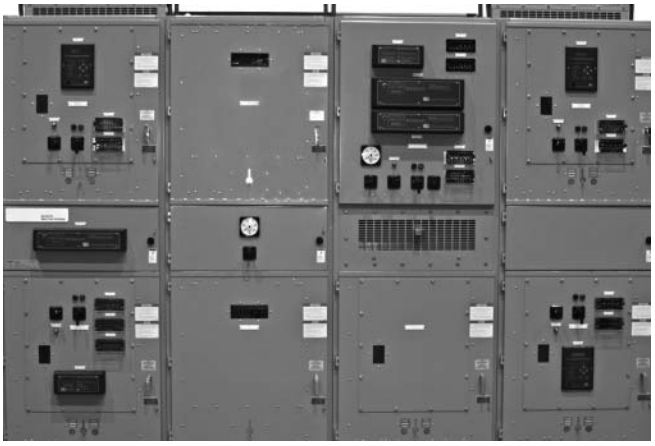
Relay Box on Breaker Compartment Door in 5/15 kV Switchgear

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. An 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 5.5-38**.

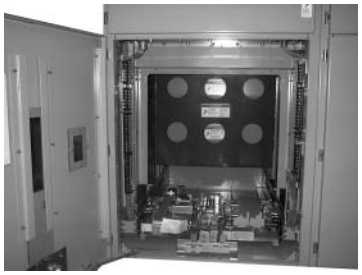
5/15 kV Arc-Resistant Switchgear



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

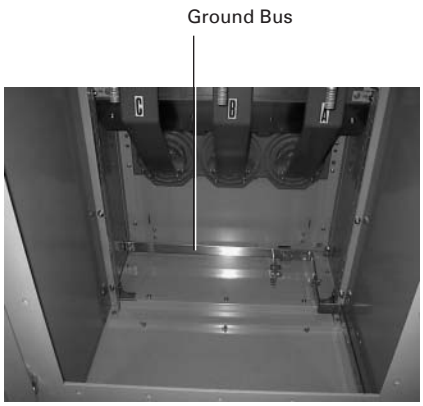
Breaker Shown Fully Withdrawn on Extension Rails

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 **Pages 5.5-19** to **5.5-29** and **Pages 5.5-38** to **5.5-40**.

27 kV Arc-Resistant Switchgear

Front View—27 kV VCP-W Arc-Resistant Switchgear (Plenum Above the Switchgear is Not Shown)

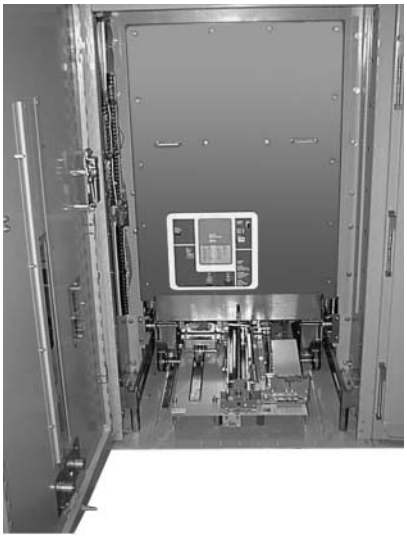
Typical 27 kV Cell—Controls in Top, Breaker in the Bottom

Rear View—Typical 27 kV Breaker Cable Termination

Note: Application layouts and dimensions—refer to **Pages 5.5-30** to **5.5-33** and **Pages 5.5-38** to **5.5-40**.

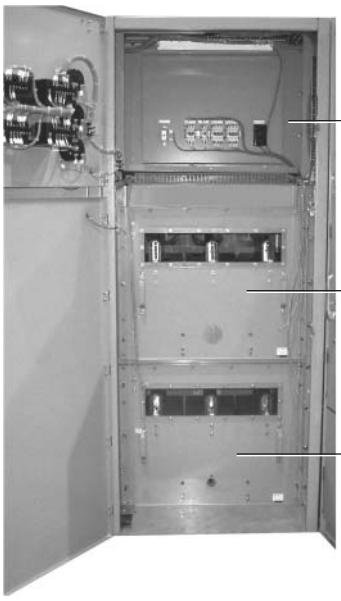
38 kV Arc-Resistant Switchgear

38 kV Arc-Resistant Switchgear (Shown Without Arc Plenum Above the Switchgear)



Circuit Breaker Compartment

Circuit Breaker Compartment Shown with Breaker Removed



Front View—VT Over VT

VT Tray—Side View (Shown Removed)

Rear Assembly

Note: Application layouts and dimensions—refer to **Pages 5.5-34** to **5.5-40**.

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Partial Discharge Sensing and Monitoring for Switchgear

Partial Discharge Equipment

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 process 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 4000V and above. Type VCP-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 consists of Eaton's InsulGard™ Relay and PD sensors specifically developed for application in the switchgear to work with the relay.

InsulGard Relay (PD Monitoring)

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 cables termination.

In 38 kV switchgear (refer to **Figure 5.3-3**), one RFCT sensor is installed around primary bushing stress shield in every breaker compartment and supplied as standard for measurement of discharges internal to the switchgear compartment. Its output is wired to terminal blocks in control compartment for easy access for periodic field measurements. It can also be connected directly to optional InsulGard relay for continuous monitoring of partial discharges. Because one RFCT sensor is included in 38 kV breaker compartment, Eaton's 38 kV switchgear is "PD Sensing Ready" when received by the customer. An additional RFCT sensor for each incoming and outgoing power cable circuits can be provided as an option for measurement of external discharges.

In 5/15/27 kV switchgear (refer to **Figure 5.3-2**), 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.

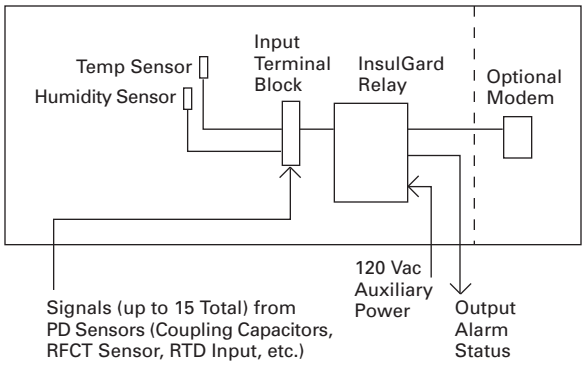
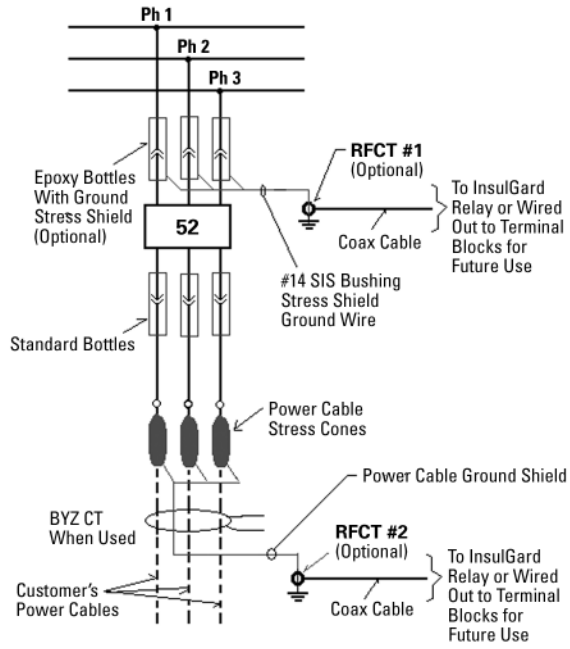


Figure 5.3-1. InsulGard Relay System

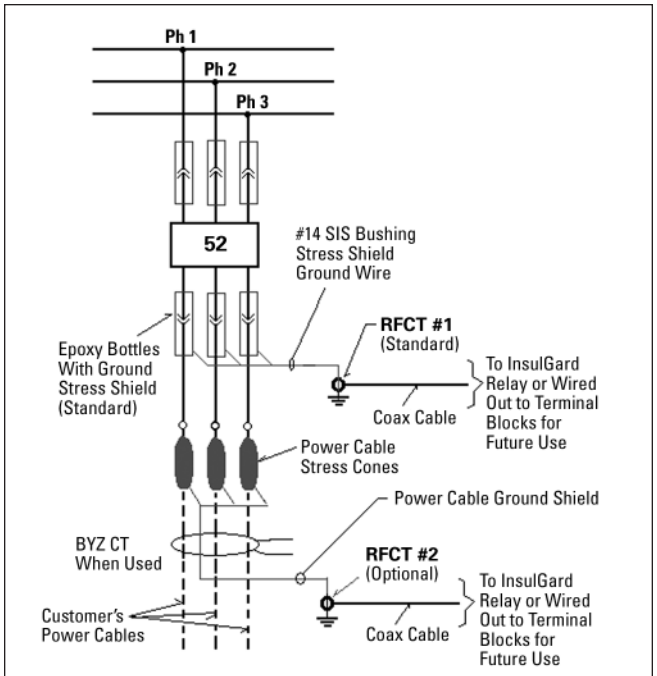


RFCT #1 detects partial discharges internal to switchgear compartment.

RFCT #2 detects partial discharges in customer's cables up to 100 ft from switchgear.

Figure 5.3-2. Typical Partial Discharge Sensor Connections (5–27 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.



RFCT #1 detects partial discharges internal to switchgear compartment.

RFCT #2 detects partial discharges in customer's cables up to 100 ft from switchgear.

Figure 5.3-3. Typical Partial Discharge Sensor Connections (38 kV Switchgear)

Partial Discharge Sensors and Monitoring for Switchgear

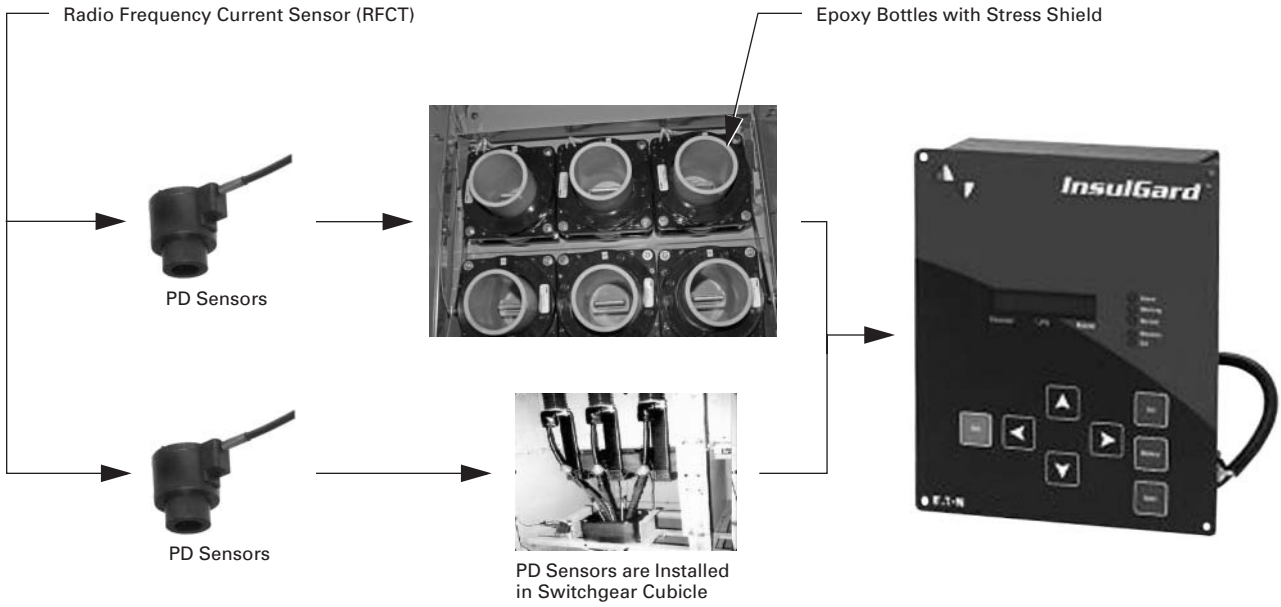
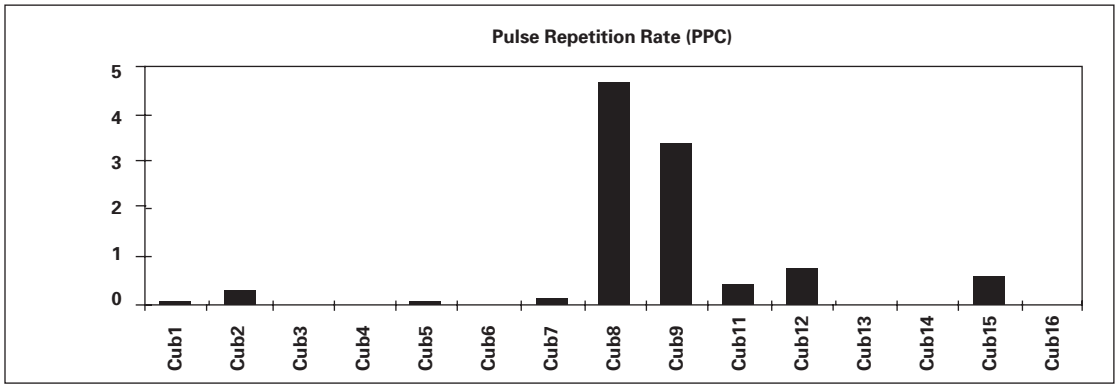
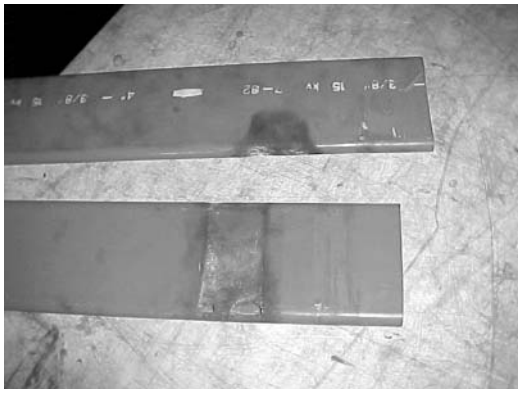


Figure 5.3-4. How the Process Works—Sensing and Data Collection





Relatively high Partial Discharge levels indicate problems in older non-fluidized epoxy insulated MV bus. Problems in cable terminations and in connected equipment can also be revealed.

Figure 5.3-5. How the Process Works—Data Analysis and Report (Sample)

Integrated Monitoring Protection and Control

Communications System

Eaton's Power Xpert® System Architecture provides a fully scalable set of hardware/software solutions that can be applied in varying levels of sophistication depending upon a customer's needs. This new architecture permits backward communication compatibility to existing Eaton and other third-party equipment, as well as expanded functionality for new devices.

The Power Xpert System Architecture uses embedded Web server technology for ease of connectivity to Ethernet Local and Wide Area Networks. The architecture includes Eaton's Power Xpert Meter, Power Xpert Gateways and Power Xpert Software. Eaton's selection matrix includes a number of deployment levels, from Web browser based monitoring of a single Power Xpert Meter, through fully customized monitoring of Eaton and third-party devices in a multi-site environment.

Medium voltage VacClad-W switchgear is ideally suited for Eaton's unique Power Xpert system incorporating PowerNet devices.

Refer to **Tab 2** for more information on communication systems.

Protective Relays

A full scope of protective relays designed to meet all application requirements is available to provide the utmost in system and component protection. Refer to **Tab 4** for further information.

Supplemental Devices

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.

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.

Standard Accessories

- One test jumper
- One levering crank
- One maintenance tool
- One lifting yoke (5–27 kV)
- One sets of rails (5–27 kV)
- One turning handle (5th wheel, 38 kV)

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

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

Discussion of changes in the Rated Voltage Range Factor, K, or "K-factor" in Circuit Breaker Rating Structure

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 breakers 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 5.4-1A** includes 5/15 kV circuit breakers rated on the basis of K = 1.0 in accordance with revised ANSI standards
- **Table 5.4-1B** includes capabilities of traditional 5/15 kV circuit breakers rated on the basis of K > 1.0
- **Table 5.4-1C** includes 27/38 kV circuit breakers rated on the basis of K = 1.0
- **Table 5.4-2** includes circuit breaker designs, rated on the basis of K = 1.0 with "extra capabilities" for those applications whose requirements go beyond what is usually experienced in normal distribution circuit applications
- **Table 5.4-3** includes circuit breakers for special generator applications

Table 5.4-1A. 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	Rated Values															
Drawout Circuit Breaker Type			Insulation Level			Short-Circuit Ratings (Reference C37.04-1999 and C37.06-2009 Except as Noted ①)					Transient Recovery Voltage Parameters are Based on TD-4					
	Maximum Voltage (V)	Power Frequency ①	Power Frequency Withstand Voltage (1 min.)	Lightning Impulse Withstand Voltage (1.2 x 50 µs)	Continuous Current ②	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 ($T_2 = t_3 \times 1.137$)	TRV Rise Time (t_3)	RRRV = u_c/t_3 ⑦	Interrupting Time	
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)
50 VCP-W 25	4.76	60	19	60	1200 2000 3000	25	50	31	65	25	8.2	50	44	0.19	50	3
50 VCP-W 40	4.76	60	19	60	1200 2000 3000	40	50	49	104	40	8.2	50	44	0.19	50	3
50 VCP-W 50	4.76	60	19	60	1200 2000 3000	50	44	59	130	50	8.2	50	44	0.19	50	3
50 VCP-W 63	4.76	60	19	60	1200 2000 3000	63	55	80	164	63	8.2	50	44	0.19	50	3
75 VCP-W 40	8.25	60	36	95	1200 2000 3000	40	50	49	104	40	14	59	52	0.27	50	3
75 VCP-W 50	8.25	60	36	95	1200 2000 3000	50	44	59	130	50	14	59	52	0.27	50	3
150 VCP-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
150 VCP-W 40	15	60	36	95	1200 2000 3000	40	50	49	104	40	25.7	75	66	0.39	50	3
150 VCP-W 50	15	60	36	95	1200 2000 3000	50	44	59	130	50	25.7	75	66	0.39	50	3
150 VCP-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 4000A fan-cooled rating is available for 3000A 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 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 E_2/T_2.
⑧ These circuit breakers were tested to the preferred TRV ratings specified in C37.06-2000.

Table 5.4-1A. Available VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards (Rated K = 1.0) (Continued)

Identification	Rated Values												
Drawout Circuit Breaker Type				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					
	Continuous Current	Operating Duty	Mechanical Endurance					Capacitor Bank Current		Inrush Current	Inrush Frequency	Voltage = 1.44 x V	Current = 0.25 x I
Units	A rms	Duty Cycle	No-Load Operations ⑨⑩	Class	A rms	Class	A rms	Class	A rms	kA Peak	kHz	kV rms	kA rms
50 VCP-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
50 VCP-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
50 VCP-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
50 VCP-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
75 VCP-W 40	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	12	10
75 VCP-W 50	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	12	12.5
150 VCP-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
150 VCP-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
150 VCP-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
150 VCP-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

⑨ Each operation consists of one closing plus one opening.
⑩ 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.

5

Table 5.4-1B. Available 5/15 kV VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards (Rated K > 1) ①②

Identification			Rated Values												Related Required Capabilities					
Circuit Breaker Type	Nominal Voltage Class	Nominal 3-Phase MVA Class	Voltage		Insulation Level		Current		Rated Transient Recovery Voltage			Rated Interrupting Time	Rated Permissible Tripping Delay	Rated Reclosing Time	Rated Maximum Voltage Divided by K	Current Values				Asymmetry Factor for VCP-W Breakers
			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 ⑤					Maximum Sym. Interrupting Capability	3-Second Short-Time Current Carrying Capability	Closing and Latching Capability (Momentary) ⑨		
																K Times Rated Short-Circuit Current ③		2.7 K Times Rated Short-Circuit Current	1.6 K Times Rated Short-Circuit Current	
	kV Class	MVA Class	V kV rms	K ③	kV rms	kV Crest	④ Amp	I ③ kA rms	E2 kV Crest	T2 µS	kV/µS	⑥ Cycles	Y ⑦ Sec.	⑧ ms	V/K kV rms	KI kA rms	KI kA rms	2.7 KI kA Crest	1.6 KI ⑩ kA rms asym.	⑪ S
50 VCP-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
50 VCP-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
50 VCP-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
75 VCP-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
150 VCP-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
150 VCP-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
150 VCP-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 **Tables 5.4-1A** and **5.4-2**.

② 5 and 15 kV circuit breakers are UL listed.

③ 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.

④ 4000A continuous rating is available for 5/15 kV. 3000A continuous rating is available for 38 kV. Contact Eaton for details.

⑤ $RRRV = 1.137 \frac{E_2}{T_2}$

⑥ 3-cycle rating available, refer to **Tables 5.4-1A** and **5.4-2**.

⑦ 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.

⑧ 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.

⑨ For higher close and latch ratings, refer to **Table 5.4-2**.

⑩ Included for reference only.

⑪ Asymmetrical interrupting capability = "S" times symmetrical interrupting capability, both at specified operating voltage.

Table 5.4-1C. Available 27/38 kV VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards ①②

Identification			Rated Values												Related Required Capabilities					
Circuit Breaker Type	Nominal Voltage Class	Nominal 3-Phase MVA Class	Voltage		Insulation Level		Current		Rated Transient Recovery Voltage			Rated Interrupting Time	Rated Permissible Tripping Delay	Rated Reclosing Time	Rated Maximum Voltage Divided by K	Current Values				Asymmetry Factor for VCP-W Breakers
																Maximum Sym. Interrupting Capability	3-Second Short-Time Current Carrying Capability	Closing and Latching Capability (Momentary) ⑨		
																K Times Rated Short-Circuit Current ③		2.7 K Times Rated Short-Circuit Current	1.6 K Times Rated Short-Circuit Current	
			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 ⑤									
	kV Class	MVA Class	V kV rms	K ③	kV rms	kV Crest	④ Amp	I ③ kA rms	E2 kV Crest	T2 µS	kV/µS	⑥ Cycles	Y ⑦ Sec.	⑧ ms	V/K kV rms	KI kA rms	KI kA rms	2.7 KI kA Crest	1.6 KI ⑩ kA rms asym.	⑪ S
270 VCP-W 750	27	—	27	1.0	60	125	1200 2000	16	51	105	0.55	5	2	300	27	16	16	43	26	1.2
270 VCP-W 1000	27	—	27	1.0	60	125	1200 2000	22	51	105	0.55	5	2	300	27	22	22	60	35	1.2
270 VCP-W 1250	27	—	27	1.0	60	125	1200 2000	25	51	105	0.55	5	2	300	27	25	25	68	40	1.2
270 VCP-W 40	27	—	27	1.0	60	125	1200 2000	40	51	105	0.55	5	2	300	27	40	40	108	64	1.2
380 VCP-W 16	34.5	—	38	1.0	80	170 ⑫	1200 2000	16	71	125	0.64	5	2	300	38	16	16	43	26	1.2
380 VCP-W 21	34.5	—	38	1.65	80	170 ⑫	1200 2000	21	71	125	0.64	5	2	300	23	35	35	95	56	1.2
380 VCP-W 25	34.5	—	38	1.0	80	170 ⑫	1200 2000	25	71	125	0.64	5	2	300	38	25	25	68	40	1.2
380 VCP-W 32	34.5	—	38	1.0	80	170 ⑫	1200 2000 2500	31.5	71	125	0.64	5	2	300	38	31.5	31.5	85	51	1.2
380 VCP-W 40	34.5	—	38	1.0	80	170 ⑫	1200 2000 2500	40	71	125	0.64	5	2	⑬	38	40	40	108	64	1.2

① For capacitor switching, refer to **Table 5.4-2**.

② 27 and 38 kV breakers are not UL listed.

③ 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.

④ 4000A continuous rating is available for 5/15 kV. 3000A continuous rating is available for 38 kV. Contact Eaton for details.

⑤ $RRRV = 1.137 \frac{E_2}{T_2}$

⑥ 3-cycle rating available, refer to **Table 5.4-2**.

⑦ 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.

⑧ 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.

⑨ For higher close and latch ratings, refer to **Table 5.4-2**.

⑩ Included for reference only.

⑪ Asymmetrical interrupting capability = "S" times symmetrical interrupting capability, both at specified operating voltage.

⑫ ANSI standard requires 150 kV BIL. All 38 kV ratings are tested to 170 kV BIL.

⑬ Type 380 VCP-W 40 circuit breaker is not rated for rapid reclosing.

Industry Leader VCP-WC

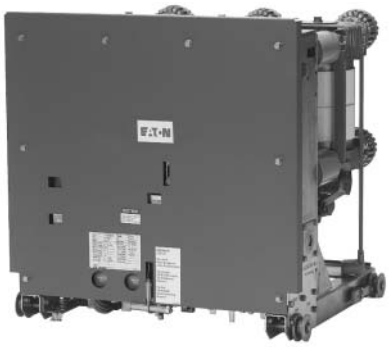
Introducing the VCP-WC extra capability medium voltage drawout circuit breaker. Designed to provide all the industry-leading features expected of the VCP-W, plus extra capabilities for those application requirements that go beyond what is usually experienced. The performance enhancement features of the 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

Vacuum Circuit Breaker Design Leadership

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 5.4-2. Extra Capability Type VCP-WC Ratings (Symmetrical Current Basis), Rated K = 1

Identification	Rated Values																	Mechanical Endurance
Circuit Breaker Type	Voltage		Insulation Level		Continuous Current at 60 Hz	Current					Interrupting Time ②	Maximum Permissible Tripping Delay	Rate of Rise of Recovery Voltage (RRRV) ③	Capacitor Switching Ratings				
						Short-Circuit Current								General Purpose	Definite Purpose			
														Isolated Shunt Capacitor Bank Current	Back-to-Back Capacitor Switching			
	Maximum Voltage (V)	Voltage Range Factor	Power Frequency Withstand Voltage (1 min.)	Lightning Impulse Withstand Voltage (1.2 x 50 µs)		Sym. Interrupting at Voltage (Isc)	% DC Component (Idc)	Asym. Interrupting (It)	Closing and Latching Capability	Short-Time Current for 3 Seconds ①					Capacitor Bank Current	Inrush Current	Inrush Frequency	
	kV rms	K	kV rms	kV Peak	A rms	kA rms Total	%	kA rms	kA Peak	kA rms	ms	Seconds	kV/µs	A rms	A rms	kA Peak	kHz	No-Load Operations
50 VCP-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 ⑤ 250	400 & 630 1000 ⑥ —	20 & 20 18 —	6.5 & 5.5 2.7 —	10,000 10,000 5,000
50 VCP-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 ⑤ 1000 ⑤ 250	630 ⑥ 1000 ⑥ —	15 18 —	3.5 2.7 —	10,000 10,000 5,000
50 VCP-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 ⑤ 1000 ⑤ 250	630 ⑥ 1000 ⑥ —	15 18 —	3.5 2.7 —	10,000 10,000 5,000
50 VCP-W 63C	5.95	1	24	75	1200 2000 3000 ④	63	62	83	175	63	50	2.0	1.1	250	200, 1600 ⑦ 200, 1600 ⑦ 200, 1600 ⑦	7.7 7.7 7.7	465 465 465	10,000 10,000 10,000
75 VCP-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 ⑤ 1000 ⑤ 250	630 ⑥ 1000 ⑥ —	15 18 —	3.5 2.7 —	10,000 10,000 5,000
150 VCP-W 25C	17.5	1	42	95	1200 2000 3000 ④	25	50 75 75	31 36 36	97 ⑧	25	50	2.0	0.9 0.9 0.8	400 & 600 ⑨ 1000 ⑤⑨ 250 ⑨	400 & 600 ⑨ 1000 ⑥⑨ —	20 & 20 18 —	6.5 & 5.5 2.7 —	10,000 10,000 5,000
150 VCP-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 ⑤⑨ 1000 ⑤⑨ 250 ⑨	630 ⑥⑨ 1000 ⑥⑨ —	15 18 —	3.5 2.7 —	10,000 10,000 5,000
150 VCP-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 ⑤⑨ 1000 ⑤⑨ 250 ⑨	630 ⑥⑨ 1000 ⑥⑨ —	15 18 —	3.5 2.7 —	10,000 10,000 5,000
150 VCP-W 63C	15	1	42	95	1200 2000 3000 ④	63	62	83	175	63	50	2.0	1.1	250	200, 1600 ⑦ 200, 1600 ⑦ 200, 1600 ⑦	7.7 7.7 7.7	465 465 465	10,000 10,000 10,000

Note: Refer to **Page 5.4-7** for footnotes.

Table 5.4-2. VCP-WC Ratings (Symmetrical Current Basis), Rated K = 1 (Continued)

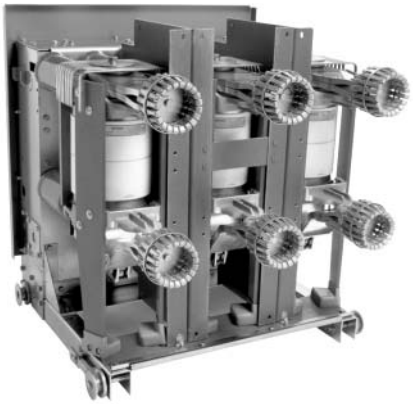
Identification	Rated Values																			
Circuit Breaker Type	Voltage		Insulation Level		Continuous Current at 60 Hz	Current					Interrupting Time ②	Maximum Permissible Tripping Delay	Rate of Rise of Recovery Voltage (RRRV) ③	Capacitor Switching Ratings					Mechanical Endurance
						Short-Circuit Current								General Purpose		Definite Purpose			
														Cable Charging Current	Isolated Shunt Capacitor Bank Current	Back-to-Back Capacitor Switching			
	Maximum Voltage (V)	Voltage Range Factor	Power Frequency Withstand Voltage (1 min.)	Lightning Impulse Withstand Voltage (1.2 x 50 µs)		Sym. Interrupting at Voltage (Isc)	% DC Component (Idc)	Asym. Interrupting (I_t)	Closing and Latching Capability	Short-Time Current for 3 Seconds ①						Capacitor Bank Current	Inrush Current	Inrush Frequency	
	kV rms	K	kV rms	kV Peak	A rms	kA rms Total	%	kA rms	kA Peak	kA rms	ms	Seconds	kV/µs	A rms	A rms	A rms	kA Peak	kHz	No-Load Operations
270 VCP-W 25C	27	1	60	125	1200 1600	25	75	36	85	25 ⑩	50	2.0	1.1	—	400	400	20	4.2	5,000
270 VCP-W 32C	27	1	60	125	1200 1600	31.5	55	40	100	31.5 ⑪	50	2.0	1.1	—	400	400	20	4.2	5,000
270 VCP-W 40C	27	1	60	125	1200 1600	40	50	49	112	40 ⑫	50	2.0	1.1	—	400	400	20	4.2	5,000
380 VCP-W 16C	38	1	80	170	1200 2000	16	75	23.3	50	16	50	2.0	0.7 1.3	50 50	250 250 & 1000	250 250 & 1000	20 20 & 20	4.4 5 & 5	10,000
380 VCP-W 25C	38	1	80	170	1200 2000	25	65	34.0	75	25	50	2.0	0.7 1.3	50 50	250 250 & 1000	250 250 & 1000	20 20 & 20	4.4 5 & 5	10,000
380 VCP-W 32C	38	1	80	170	1200 2000 2500 3000FC ⑬	33.1	57	42.5	91	31.5	50	2.0	0.7 1.3 0.7 1.3	50 50 50 50	250 250 & 1000 — 250 & 1000	250 250 & 1000 — 250 & 1000	20 20 & 20 — 20 & 20	4.4 5 & 5 — 5 & 5	10,000
380 VCP-W 40C	38	1	80	170	1200 2000 2500 3000FC ⑭	40	63	53.5	107	40	50	2.0	0.7	50 50 50 50	⑮ — — —	⑮ — — —	⑮ — — —	⑮ — — —	10,000

① Except as noted.
② 3 cycles.
③ Contact Eaton for higher RRRV or for more information.
④ 4000A FC rating available.
⑤ Breaker tested to 2700A single bank switching for momentary load (thermal derating must consider harmonic content of current waveform).
⑥ Breaker tested to 1270A back to back switching for momentary load (thermal derating must consider harmonic content of current waveform).
⑦ C37.04.a-2003 Class C2 at 15 kV.
⑧ Close and Latch Current for 1200A Type 150 VCP-W 25C is proven at 15 kV. For sealed interrupters at high altitudes, switching voltage is not derated.
⑨ Capacitor Switching Ratings are proven at 15 kV. For sealed interrupters at high altitudes, switching voltage is not derated.
⑩ 2.5 seconds.
⑪ 1.6 second.
⑫ 1 second.
⑬ 2000A FC to 3000A.
⑭ 2500A FC to 3000A.
⑮ Contact Eaton for capacitor switching ratings.

Note: 38 kV, 2500A and 3000A WC 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 Corporation 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 3000A (4000A 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 4000A (5000A 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 6000A (7000A 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 5.4-1**. 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 5.4-2**.

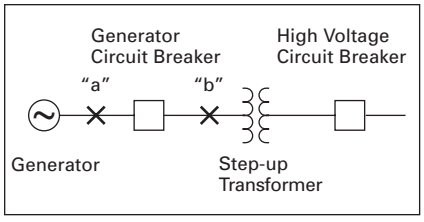


Figure 5.4-1. Generator Circuit Application

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 4000A with natural air convection cooling, and up to 5000A with suitable enclosure fan cooling during overload conditions. VCP-WRG fixed circuit breakers are designed to reliably operate up to 6000A with natural air convection cooling and up to 7000A with suitable enclosure fan cooling during overload conditions.

Unique Fault Current Conditions

System-source (aka, transformer-fed) faults (see **Figure 5.4-1**, 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 5.4-1**, fault location "b") can cause a severe condition called "Delayed Current Zero," see **Figure 5.4-2**). 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.

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.

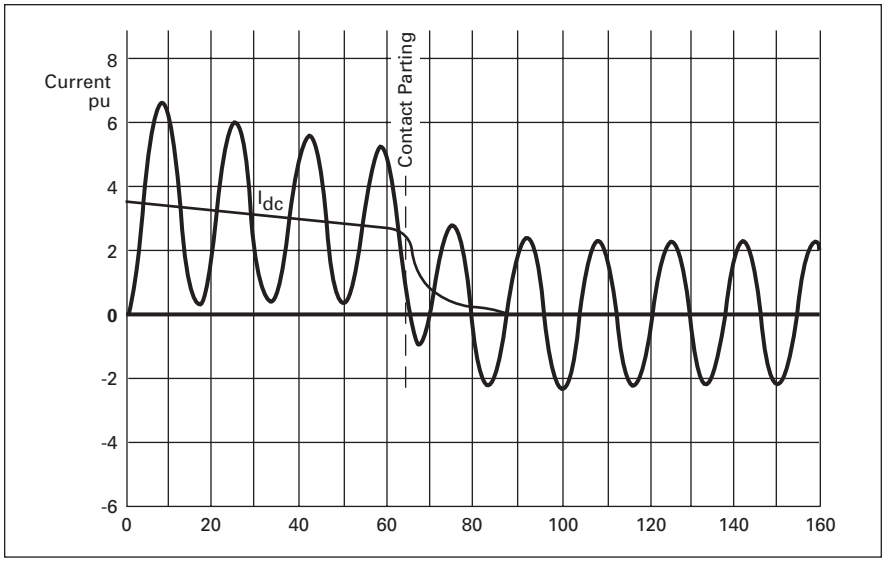


Figure 5.4-2. Generator-Fed Faults Can Experience Delayed Current Zero, Where the High Inductance to Resistance Ratio of the System Can Cause the DC Component of the Fault Current to Exceed 100%

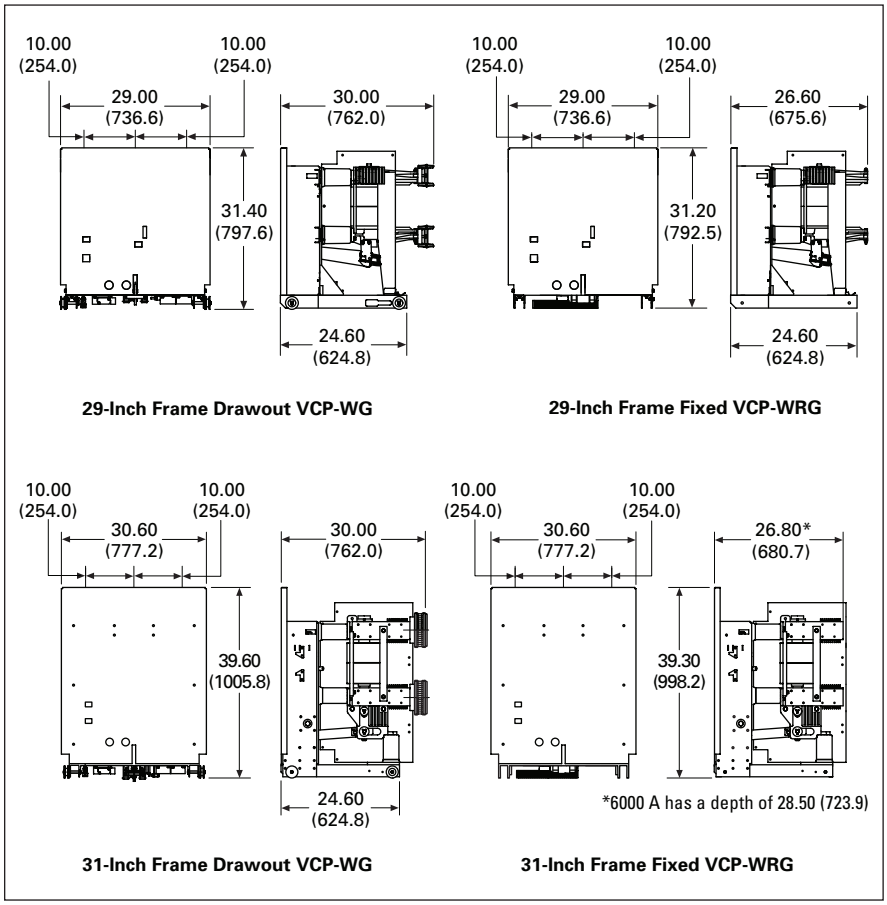


Figure 5.4-3. Type VCP-WG (Drawout) and Type VCP-WRG (Fixed) Circuit Breakers

5 kV Class Generator Circuit Breaker Ratings

Table 5.4-3. Generator Circuit Breaker Types: VCP-WG (Drawout—DO) / VCP-WRG (Fixed—FIX)

Description	Units	Short-Circuit Current (Isc)									
		50 kA				63 kA				75 kA	
Maximum Voltage (V): 5 kV											
Frame in Inches (mm) (see **Figure 5.4-3** on **Page 5.4-9**)	—	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 2000 3000	1200 2000 3000	— — —	— — —	1200 2000 3000	1200 2000 3000	— — —	— — —	1200 2000 3000	1200 2000 3000
		4000 ① — —	4000 ① — —	4000 5000 ① —	4000 5000 6000	4000 ① — —	4000 ① — —	4000 5000 ① —	4000 5000 6000	4000 5000 ① —	4000 5000 6000
		— —	— —	— —	6300 ① 7000 ①	— —	— —	— —	6300 ① 7000 ①	— —	6300 ① 7000 ①
Dielectric Strength Power frequency withstand voltage Lightning impulse withstand voltage	 kV rms kV peak	 19 60	 19 60	 19 60	 19 60	 19 60	 19 60	 19 60	 19 60	 19 60	 19 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 Asymmetrical current interrupting capability Ref: Minimum opening time Short-time current carrying capability Duration of short-time current	kA rms % DC ms kA rms sec	50 75 30 50 3	50 75 30 50 3	50 75 54 50 2.3	50 75 54 50 2.3	63 75 30 63 3	63 75 30 63 3	63 75 54 63 1.4	63 75 54 63 1.4	75 63 54 75 1	75 63 54 75 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) Transient recovery voltage—Peak (E2 = 1.84 x V)	kV / µs kV peak	3.0 9.2	3.0 9.2	3.0 9.2	3.0 9.2	3.0 9.2	3.0 9.2	3.0 9.2	3.0 9.2	3.0 ② 9.2 ②	3.0 ② 9.2 ②
Transient recovery voltage—Time to Peak (T2 = 0.62 x V)	µs	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	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 / µs	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)	µs	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/µs; or T2 is <65 µs.

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 5.4-4. 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	
Maximum Voltage (V): 15 kV											
Frame in Inches (mm) (see **Figure 5.4-3** on **Page 5.4-9**)	—	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 2000 3000	1200 2000 3000	— — —	— — —	1200 2000 3000	1200 2000 3000	— — —	— — —	1200 2000 3000	1200 2000 3000
		4000 ① — —	4000 ① — —	4000 5000 ① —	4000 5000 6000	4000 ① — —	4000 ① — —	4000 5000 ① —	4000 5000 6000	4000 5000 ① —	4000 5000 6000
		— —	— —	— —	6300 ① 7000 ①	— —	— —	— —	6300 ① 7000 ①	— —	6300 ① 7000 ①
Dielectric Strength Power frequency withstand voltage Lightning impulse withstand voltage	 kV rms kV peak	 36 95	 36 95	 36 95	 36 95	 36 95	 36 95	 36 95	 36 95	 36 95	 36 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 Asymmetrical current interrupting capability Ref: Minimum opening time Short-time current carrying capability Duration of short-time current	kA rms % DC ms kA rms s	50 75 30 50 3	50 75 30 50 3	50 75 54 50 2.3	50 75 54 50 2.3	63 75 30 63 3	63 75 30 63 3	63 75 54 63 1.4	63 75 54 63 1.4	75 63 54 75 1	75 63 54 75 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) Transient recovery voltage—Peak (E2 = 1.84 x V)	kV / µs kV peak	3.4 27.6	3.4 27.6	3.4 27.6	3.4 27.6	3.4 27.6	3.4 27.6	3.4 27.6	3.4 27.6	3.4 ② 30.9 ②	3.4 ② 30.9 ②
Transient recovery voltage—Time to Peak (T2 = 0.62 x V)	µs	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	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 / µs	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)	µs	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/µs; or T2 is <65 µs.

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.

Type 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 5.4-5**.

Figure 5.4-4 below shows the sequence of events in the course of circuit interruption, along with applicable VCP-W circuit breaker timings.

Table 5.4-5. 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, 250 Vdc	All	45–60	30–45	30–38
120V, 240 Vac	All	45–60	—	—
120V or 240 Vac capacitor trip	All	—	26–41	26–38
Optional—undervoltage trip release 48V, 125V, 250 Vdc	All	—	30–45	30–45

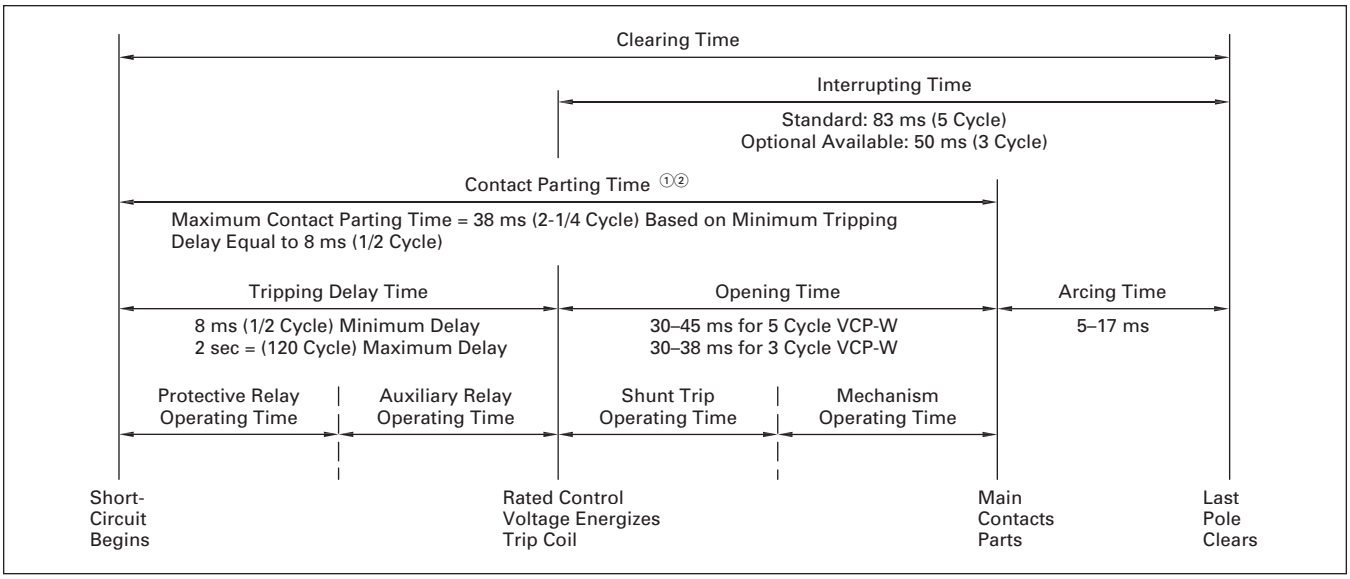


Figure 5.4-4. Sequence of Events and Circuit Breaker Operating Times

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 ≥ 50% (S factor ≥ 1.2) for all VCP-W circuit breakers.

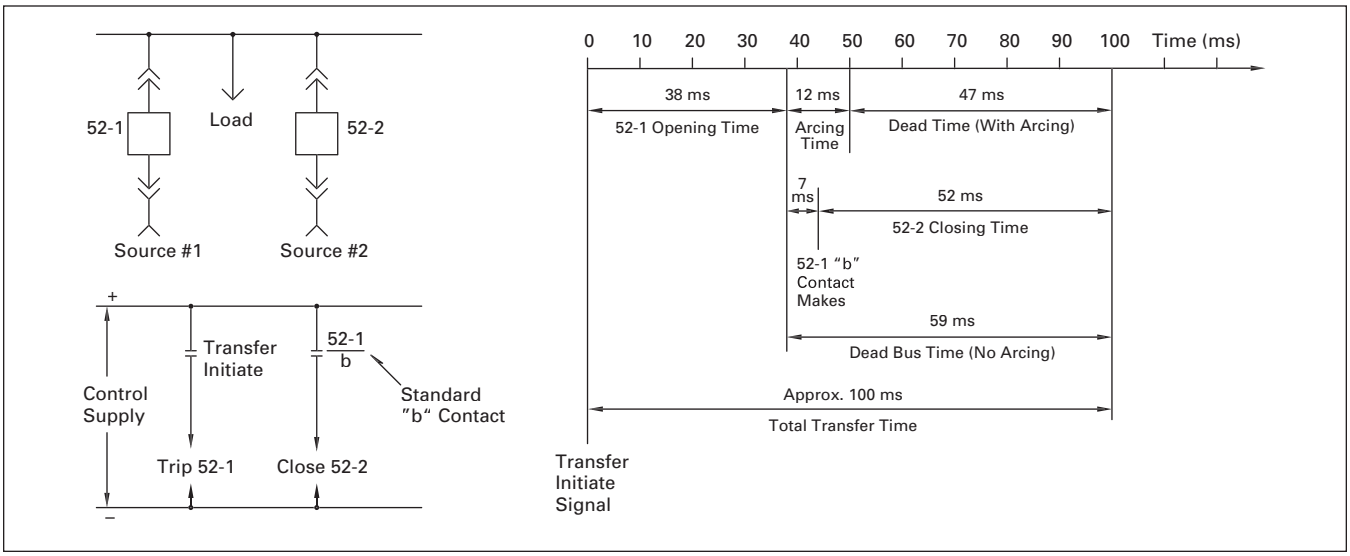


Figure 5.4-5. Typical Transfer Times ③—Fast Sequential Transfer

③ Times shown are based on 60 Hz.

Application Quick Check

See **Table 5.4-7** for application of circuit breakers in a radial system supplied from a single-source transformer. Short-circuit duty was determined using E/X amperes and 1.0 multiplying factor for X/R ratios in the range of 15 to 40.

Usual Service Conditions

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

- Altitude does not exceed 3300 feet (1000m)
- 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 (1006m)

The rated one-minute power frequency withstand voltage, the impulse withstand voltage, the continuous current rating and the maximum voltage rating must be multiplied by the appropriate correction factor in **Table 5.4-9** 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.

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 5.4-6** provides derating factors, which must be applied to breaker interrupting current at various frequencies.

Table 5.4-6. 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.

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.

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 5.4-8** provides nominal current rating for VCP-W breakers when operated at frequencies below 60 Hz.

Table 5.4-7. Radial System Application Information

Source Transformer MVA Rating		Operating Voltage kV					
Motor Load		**2.4**	**4.16**	**6.6**	**12**	**13.8**	**27**
100%	**0%**						
Up to 5	Up to 7.5	50 VCP-W 250 ① (36 kA)	50 VCP-W 250 ① (33.2 kA)	150 VCP-W 500 (23 kA)	150 VCP-W 500 (22.5 kA)	150 VCP-W 500 (19.6 kA)	270 VCP-W 750 (16 kA)
7.5 10 ②	10 10	50 VCP-W 350 (49 kA)					
10	12 ②						
12	15		50 VCP-W 350 (46.9 kA)	75 VCP-W 500 (41.3 kA)			
15	20						
20 ②					150 VCP-W 750 (35 kA)	150 VCP-W 750 (30.4 kA)	
	25 30	Breaker type and symmetrical interrupting capability at the operating voltage					
	50 ②				150 VCP-W 1000 (46.3 kA)	150 VCP-W 1000 (40.2 kA)	270 VCP-W 1000 (22 kA)
25	50						
30							270 VCP-W 1250 (25 kA)

① Also includes 50VCPW-ND250.
② Transformer impedance 6.5% or more. All other transformer impedances are 5.5% or more.

Table 5.4-8. Current Ratings

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

Table 5.4-9. 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

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

Load Current Switching

Table 5.4-10 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.

Table 5.4-10. 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.

Table 5.4-11. Heat Loss in Watts at Full Rating, at 60 Hz

Type of Switchgear Assembly	Breaker Rating	1200A	2000A	2500A	3000A	4000A Fan Cooled
VCP-W	5, 15, and 27 kV	600W	1400W	—	2100W	3700W
VCP-W	38 kV	850W	1700W	2300W	3800W	—

Other Components

Each CT, standard accuracy	50W
Each CT, high accuracy	100W
Each VT	60W
CPT single-phase, 25 kVA	450W
CPT single-phase, 45 kVA	892W
Space heater—each	250W

Standard Metal-Clad Switchgear Assembly Ratings

VacClad-W metal-clad 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 5.4-12. Standard VCP-W (Non-Arc-Resistant) Metal-Clad Switchgear Ratings Per IEEE C37.20.2-1999 ①②

Rated Maximum Voltage	(Ref.) Rated Voltage Range Factor K	(Ref.) Rated Short-Circuit Current I	Insulation Level		Rated Main Bus Continuous Current ③④	Rated Short-Time Short-Circuit Current Withstand (2-Second)	Rated Momentary Short-Circuit Current Withstand (10-Cycle) (167 ms)	
			Power Frequency Withstand Voltage, 60 Hz, 1 Minute	Lightning Impulse Withstand Voltage [LIWV] (BIL)		K*I ⑤	2.7 *K*I ⑥	1.6 *K* I ⑦ (Ref. only)
kV rms		kA rms	kV rms	kV Peak	Amperes	kA rms Sym.	kA Crest	kA rms Asym.
4.76	1	25	19	60	1200, 2000, 3000, 4000	25	68	40
	1.24	29			1200, 2000, 3000, 4000	36	97	58
	1	40			1200, 2000, 3000, 4000	40	108	64
	1.19	41			1200, 2000, 3000, 4000	49	132	78
	1	50			1200, 2000, 3000, 4000	50	135	80
	1	63			1200, 2000, 3000, 4000	63	170	101
8.25	1.25	33	36	95	1200, 2000, 3000, 4000	41	111	66
	1	50			1200, 2000, 3000, 4000	50	135	80
15	1.3	18	36	95	1200, 2000, 3000, 4000	23	62	37
	1	25			1200, 2000, 3000, 4000	25	68	40
	1.3	28			1200, 2000, 3000, 4000	36	97	58
	1	40			1200, 2000, 3000, 4000	40	108	64
	1.3	37			1200, 2000, 3000, 4000	48	130	77
	1	50			1200, 2000, 3000, 4000	50	135	80
	1	63			1200, 2000, 3000, 4000	63	170	101
27	1	16	60	125	1200, 2000, 2500, 2700	16	43	26
	1	22			1200, 2000, 2500, 2700	22	60	35
	1	25			1200, 2000, 2500, 2700	25	68	40
	1	31.5			1200, 2000, 2500, 2700	31.5	85	51
	1	40			1200, 2000, 2500, 2700	40	108	64
38	1	16	80	150 ⑧	1200, 2000, 2500	16	43	26
	1	25			1200, 2000, 2500	25	68	40
	1	31.5			1200, 2000, 2500	31.5	85	51
	1.65	23			1200, 2000, 2500	35	95	56
	1	40			1200, 2000, 2500	40	108	64
38	1	16	80	170 ⑨	1200, 2000, 2500, 3000	16	43	26
	1	25			1200, 2000, 2500, 3000	25	68	40
	1	31.5			1200, 2000, 2500, 3000	31.5	85	51
	1.65	23			1200, 2000, 2500, 3000	35	95	56
	1	40			1200, 2000, 2500, 3000	40	108	64

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 Circuit breaker requires forced air cooling to carry 4000A at 4.76, 8.25 and 15 kV, and 3000A at 38 kV.
④ 27 kV 2500A and 2700A main bus ratings are available in two-high design configurations only.
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 C37.20.2-1999 and ANSI C37.06-2000.
⑦ These values exceed 1.55*K*I required by IEEE C37.20.2-1999.
⑧ This is a standard IEEE C37.20.2 rating for 38 kV Class of switchgear.
⑨ 170 kV LIWV (BIL) rating available as an option, except when a control power transformer is included.

5

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 5.4-13. 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 C37.20.2-1999						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)		K*I ⑤	2.7 *K*I ⑥	1.6 *K* I ⑦ (Ref. only)	IEEE C37.20.7	EEMAC G14-1	Isc	2.6*Isc	
kV rms		kA rms	kV rms	kV Peak	Amperes	kA rms Sym.	kA Crest	kA rms Asym.			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
	1	63			1200, 2000, 3000, 4000	63	170	101	2B	—	63	170	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 2500A.

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 C37.20.2-1999 and ANSI C37.06-2000.

⑦ These values exceed 1.55*K*I required by IEEE C37.20.2-1999.

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

Surge Protection

Eaton's VacClad-W metal-clad switchgear is applied over a broad range of circuits, and is one of the many types of equipment in the total system. The distribution system can be subject to voltage transients caused by lighting or switching surges.

Recognizing that distribution system can be subject to voltage transients caused by lighting or switching, the industry has developed standards to provide guidelines for surge protection of electrical equipment. Those guidelines should be used in design and protection of electrical distribution systems independent of the circuit breaker interrupting medium. The industry standards are:

ANSI C62
Guides and Standards for Surge Protection

IEEE 242—Buff Book
IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

IEEE 141—Red Book
Recommended Practice for Electric Power Distribution for Industrial Plants

IEEE C37.20.2
Standards for Metal-Clad Switchgear

Eaton's medium voltage metal-clad and metal-enclosed switchgear that uses vacuum circuit breakers is applied over a broad range of circuits. It is one of the many types of equipment in the total distribution system. Whenever a switching device is opened or closed, certain interactions of the power system elements with the switching device can cause high frequency voltage transients in the system. Due to the wide range of applications and variety of ratings used for different elements in the power systems, a given circuit may or may not require surge protection. Therefore, Eaton does not include surge protection as standard with its metal-clad or metal-enclosed medium voltage switchgear. The user exercises the options as to the type and extent of the surge protection necessary depending on the individual circuit characteristics and cost considerations.

The following are Eaton's recommendations for surge protection of medium voltage equipment. **Please note these recommendations are valid when using Eaton's vacuum breakers only.**

Surge Protection Recommendations:

Note: The abbreviation ZORC® used in the text below refers to Surge Protection Device manufactured by Strike Technology (Pty) Ltd. An equivalent device offered by other manufacturers, such as Type EHZ by ABB, and Protec Z by Northern Technologies SA can also be used.

1. For circuits exposed to lightning, surge arresters should be applied in line with Industry standard practices.
2. Transformers
   a. Close-Coupled to medium voltage primary breaker: Provide transients surge protection, such as Surge Arrester in parallel with RC Snubber, or ZORC®. The surge protection device selected should be located and connected at the transformer primary terminals or it can be located inside the switchgear and connected on the transformer side of the primary breaker.
   b. Cable-Connected to medium voltage primary breaker: Provide transient surge protection, such as Surge Arrester in parallel with RC Snubber, or ZORC for transformers connected by cables with lengths up to 75 feet. The surge protection device should be located and connected at the transformer terminals. No surge protection is needed for transformers with lightning impulse withstand ratings equal to that of the switchgear and connected to the switchgear by cables at least 75 feet or longer. For transformers with lower BIL, provide surge arrester in parallel with RC Snubber or ZORC.

RC Snubber and/or ZORC damp internal transformer resonance:

The natural frequency of transformer windings can under some circumstances be excited to resonate. Transformer windings in resonance can produce elevated internal voltages that produce insulation damage or failure. An RC Snubber or a ZORC applied at the transformer terminals as indicated above can damp internal winding resonance and prevent the production of damaging elevated internal voltages. This is typically required where rectifiers, UPS or similar electronic equipment is on the transformer secondary.

3. Arc-Furnace Transformers—Provide Surge Arrester in parallel with RC Snubber, or ZORC at the transformer terminals.
4. Motors—Provide Surge Arrester in parallel with RC Snubber, or ZORC at the motor terminals. For those motors using VFDs, surge protection should be applied and precede the VFD devices as well.
5. Generators—Provide station class Surge Arrester in parallel with RC Snubber, or ZORC at the generator terminals.
6. Capacitor Switching—No surge protection is required. Make sure that the capacitor's lightning impulse withstand rating is equal to that of the switchgear.
7. Shunt Reactor Switching—Provide Surge Arrester in parallel with RC Snubber, or ZORC at the reactor terminals.
8. Motor Starting Reactors or Reduced Voltage Auto-Transformers—Provide Surge Arrester in parallel with RC Snubber, or ZORC at the reactor or RVAT terminals.
9. Switching Underground Cables—Surge protection not needed.

Types of Surge Protection Devices

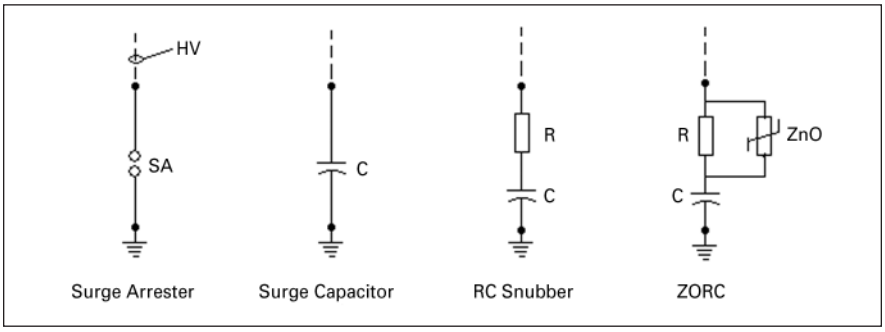


Figure 5.4-6. Surge Protection Devices

Generally surge protective devices should be located as closely as possible to the circuit component(s) that require protection from the transients, and connected directly to the terminals of the component with conductors that are as short and flat as possible to minimize the inductance. It is also important that surge protection devices should be properly grounded for effectively shunting high frequency transients to ground.

Surge Arresters

The modern metal-oxide surge arresters are recommended because this latest advance in arrester design ensures better performance and high reliability of surge protection schemes. Manufacturer's technical data must be consulted for correct application of a given type of surge arrester. Notice that published arrester MCOV (Maximum Continuous Operating Voltage) ratings are based on 40° or 45°C ambient temperature. In general, the following guidelines are recommended for arrester selections, when installed inside Eaton's medium voltage switchgear:

A. Solidly Grounded Systems: Arrester MCOV rating should be equal to 1.05 x V_{LL}/(1.732 x T), where V_{LL} is nominal line-to-line service voltage, 1.05 factor allows for +5% voltage variation above the nominal voltage according to ANSI C84.1, and T is derating factor to allow for operation at 55°C switchgear ambient, which should be obtained from the arrester manufacturer for the type of arrester under consideration. Typical values of T are: 0.946 to 1.0.

B. Low Resistant Grounded Systems (systems grounded through resistor rated for 10 seconds): Arrester 10-second MCOV capability at 60°C, which is obtained from manufacturer's data, should be equal to 1.05 x V_{LL}, where V_{LL} is nominal line-to-line service voltage, and 1.05 factor allows for +5% voltage variation above the nominal voltage.

C. Ungrounded or Systems Grounded through impedance other than 10-second resistor: Arrester MCOV rating should be equal to 1.05 x V_{LL}/T, where V_{LL} and T are as defined above.

Refer to **Table 5.4-14** for recommended ratings for metal-oxide surge arresters that are sized in accordance with the above guidelines, when located in Eaton's switchgear.

Surge Capacitors

Metal-oxide surge arresters limit the magnitude of prospective surge overvoltage, but are ineffective in controlling its rate of rise. Specially designed surge capacitors with low internal inductance are used to limit the rate of rise of this surge overvoltage to protect turn-to-turn insulation. Recommended values for surge capacitors are: 0.5 µf on 5 and 7.5 kV, 0.25 µf on 15 kV, and 0.13 µf on systems operating at 24 kV and higher.

RC Snubber

A RC Snubber device consists of a non-inductive resistor R sized to match surge impedance of the load cables, typically 20 to 30 ohms, and connected in series with a Surge Capacitor C. The Surge Capacitor is typically sized to be 0.15 to 0.25 microfarad. Under normal operating conditions, impedance of the capacitor is very high, effectively "isolating" the resistor R from the system at normal power frequencies, and minimizing heat dissipation during normal operation. Under high frequency transient conditions, the capacitor offers very low impedance, thus effectively "inserting" the resistor R in the power system as cable terminating resistor, thus minimizing reflection of the steep wave-fronts of the voltage transients and prevents voltage doubling of the traveling wave. The RC Snubber provides protection against high frequency transients by absorbing and damping and the transients. Please note RC Snubber is most effective in mitigating fast-rising transient voltages, and in attenuating reflections and resonances before they have a chance to build up, but does not limit the peak magnitude of the transient. Therefore, the RC Snubber alone may not provide adequate protection. To limit peak magnitude of the transient, application of surge arrester should also be considered.

ZORC

A ZORC device consists of parallel combination of Resistor (R) and Zinc Oxide Voltage Suppressor (ZnO), connected in series with a Surge Capacitor. The resistor R is sized to match surge impedance of the load cables, typically 20 to 30 ohms. The ZnO is a gapless metal-oxide non-linear arrester, set to trigger at 1 to 2 PU voltage, where 1 PU = 1.412*(V_{L-L}/1.732). The Surge Capacitor is typically sized to be 0.15 to 0.25 microfarad. As with RC Snubber, under normal operating conditions, impedance of the capacitor is very high, effectively "isolating" the resistor R and ZnO from the system at normal power frequencies, and minimizing heat dissipation during normal operation. Under high frequency transient conditions, the capacitor offers very low impedance, thus effectively "inserting" the resistor R and ZnO in the power system as cable terminating network, thus minimizing reflection of the steep wave-fronts of the voltage transients and prevents voltage doubling of the traveling wave. The ZnO element limits the peak voltage magnitudes. The combined effects of R, ZnO, and Capacitor of the ZORC device provides optimum protection against high frequency transients by absorbing, damping, and by limiting the peak amplitude of the voltage wave-fronts. Please note that the ZORC is not a lightning protection device. If lightning can occur or be induced in the electrical system, a properly rated and applied surge arrester must precede the ZORC.

Surge Protection Summary

Minimum protection: Surge Arrester for protection from high overvoltage peaks, or Surge Capacitor for protection from fast-rising transient. Please note that the surge arresters or surge capacitor alone may not provide adequate surge protection from escalating voltages caused by circuit resonance. Note that when applying surge capacitors on both sides of a circuit breaker, surge capacitor on one side of the breaker must be RC Snubber or ZORC, to mitigate possible virtual current chopping.

Good protection: Surge Arrester in parallel with Surge Capacitor for protection from high overvoltage peaks and fast rising transient. This option may not provide adequate surge protection from escalating voltages caused by circuit resonance. When applying surge capacitors on both sides of a circuit breaker, surge capacitor on one side of the breaker must be RC Snubber or ZORC, to mitigate possible virtual current chopping.

Better protection: RC Snubber in parallel with Surge Arrester for protection from high frequency transients and voltage peaks.

Best protection: ZORC, plus proper surge arrester preceding ZORC where needed for protection against lightning. ZORC provides protection from high frequency voltage transients and limits peak magnitude of the transient to 1 to 2 PU (see ZORC description on **Page 5.4-18** for more detail). Surge arrester provides protection from higher voltage peaks resulting from lightning surges.

Table 5.4-14. Surge Arrester Selections—Recommended Ratings

Service Voltage Line-to-Line kV	Distribution Class Arresters						Station Class Arresters					
	Solidly Grounded System		Low Resistance Grounded System		High Resistance or Ungrounded System		Solidly Grounded System		Low Resistance Grounded System		High Resistance or Ungrounded System	
	Arrester Ratings kV						Arrester Ratings kV					
	Nominal	MCOV	Nominal	MCOV	Nominal	MCOV	Nominal	MCOV	Nominal	MCOV	Nominal	MCOV
2.30	3	2.55	3	2.55	3	2.55	3	2.55	3	2.55	3	2.55
2.40	3	2.55	3	2.55	6	5.10	3	2.55	3	2.55	6	5.10
3.30	3	2.55	3	2.55	6	5.10	3	2.55	3	2.55	6	5.10
4.00	3	2.55	6	5.10	6	5.10	3	2.55	6	5.10	6	5.10
4.16	6	5.10	6	5.10	6	5.10	6	5.10	6	5.10	6	5.10
4.76	6	5.10	6	5.10	9	7.65	6	5.10	6	5.10	9	7.65
4.80	6	5.10	6	5.10	9	7.65	6	5.10	6	5.10	9	7.65
6.60	6	5.10	6	5.10	9	7.65	6	5.10	6	5.10	9	7.65
6.90	6	5.10	6	5.10	9	7.65	6	5.10	9	7.65	9	7.65
7.20	6	5.10	6	5.10	10	8.40	6	5.10	9	7.65	10	8.40
8.32	9	7.65	9	7.65	12	10.20	9	7.65	9	7.65	12	10.20
8.40	9	7.65	9	7.65	12	10.20	9	7.65	9	7.65	12	10.20
11.00	9	7.65	9	7.65	15	12.70	9	7.65	10	8.40	15	12.70
11.50	9	7.65	10	8.40	18	15.30	9	7.65	12	10.20	18	15.30
12.00	10	8.40	10	8.40	18	15.30	10	8.40	12	10.20	18	15.30
12.47	10	8.40	12	10.20	18	15.30	10	8.40	12	10.20	18	15.30
13.20	12	10.20	12	10.20	18	15.30	12	10.20	12	10.20	18	15.30
13.80	12	10.20	12	10.20	18	15.30	12	10.20	15	12.70	18	15.30
14.40	12	10.20	12	10.20	21	17.00	12	10.20	15	12.70	21	17.00
18.00	15	12.70	15	12.70	27	22.00	15	12.70	18	15.30	27	22.00
20.78	18	15.30	18	15.30	30	24.40	18	15.30	21	17.00	30	24.40
22.00	18	15.30	18	15.30	30	24.40	18	15.30	21	17.00	30	24.40
22.86	18	15.30	21	17.00	—	—	18	15.30	24	19.50	36	29.00
23.00	18	15.30	21	17.00	—	—	18	15.30	24	19.50	36	29.00
24.94	21	17.00	24	19.50	—	—	21	17.00	24	19.50	36	29.00
25.80	21	17.00	24	19.50	—	—	21	17.00	24	19.50	36	29.00
26.40	21	17.00	24	19.50	—	—	21	17.00	27	22.00	39	31.50
33.00	27	22.00	30	24.40	—	—	27	22.00	36	29.00	45	36.50
34.50	30	24.40	30	24.40	—	—	30	24.40	36	29.00	48	39.00
38.00	30	24.40	—	—	—	—	30	24.40	36	29.00	—	—

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 5A and/or 120V, 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 5A 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.

When utilizing the MP-3000 Motor Protective Relay, it is recommended that the ratio of CT primary rating to the motor full load amperes (CTprim/Motor FLA) is selected to fall between 0.5 to 1.5.

Standard accuracy current transformers are normally more than adequate for most standard applications of microprocessor-based protective relays and meters. See **Table 5.4-17** for CT accuracy information.

Table 5.4-15. Standard Voltage Transformer Ratio Information

Rating-Volts	2400	4200	4800	7200	8400	10800	12000	14400	15600	18000	21000	24000	27000	36000
Ratio	20-1	35-1	40-1	60-1	70-1	90-1	100-1	120-1	130-1	150-1	175-1	200-1	225-1	300-1

Table 5.4-16. Standard Voltage Transformer, 60 Hz Accuracy Information

Switchgear		Voltage Transformer—ANSI Accuracy											
kV Class	kV BIL	Maximum Number Per Set and Connection	Standard Ratios	Burdens at 120 Volts				Burdens at 69.3 Volts				Thermal Rating 55°C Connection	Volt-Ampere
				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
27	125	2LL or 3LG	90, 100, 120, 130, 150, 175, 200, 225	0.3	0.3	0.3	1.2	0.3	0.3	0.3	1.2	LL LG LG ②	1000 550 1000
38	170	2LL or 3LG	175, 300	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	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 5.4-17. 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 75:5 100:5	1.2 1.2 1.2	— 2.4 2.4	— — —	C10 C10 C10	C10 C20 C20	— — —
150:5 200:5 250:5	0.6 0.6 0.6	2.4 2.4 2.4	— — —	C20 C20 ③	C20 C20 C20	C50 C50 C50
300:5 400:5 500:5	0.6 0.3 0.3	2.4 1.2 0.3	2.4 2.4 2.4	C20 C50 ③	C20 C50 C50	C100 C100 C100
600:5 800:5 1000:5	0.3 0.3 0.3	0.3 0.3 0.3	2.4 1.2 0.3	C50 C50 ③	C100 C100 C100	C200 C200 C200
1200:5 1500:5 2000:5	0.3 0.3 0.3	0.3 0.3 0.3	0.3 0.3 0.3	C100 C100 C100	C200 C200 C200	C400 C400 C400
2500:5 3000:5 4000:5	0.3 0.3 0.3	0.3 0.3 0.3	0.3 0.3 0.3	③ C100 C100	C200 C200 C200	C400 C400 C400
600:5 MR 1200:5 MR 2000:5 MR 3000:5 MR	0.3 0.3 0.3 0.3	0.3 0.3 0.3 0.3	2.4 0.3 0.3 0.3	③ ③ ③ ③	C100 C200 C200 C200	C200 C400 C400 C400
50:5 zero sequence 100:5 zero sequence	— —	— —	— —	— —	C10 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.

5

Control Equipment

Circuit Breaker Control

Eaton's VCP-W circuit breaker has a motor charged spring type stored energy closing mechanism. Closing the breaker charges accelerating springs. Protective relays or the control switch will energize a shunt trip coil to release the accelerating springs and open the breaker. This requires a reliable source of control power for the breaker to function as a protective device. Typical AC and DC control schematics for type VCP-W circuit breakers are shown on **Pages 5.4-24** and **5.4-25**.

5

For AC control, a capacitor trip device is used with each circuit breaker shunt trip to ensure that energy will be available for tripping during fault conditions. A control power transformer is required on the source side of each incoming line breaker. Closing bus tie or bus sectionalizing breakers will require automatic transfer of control power. This control power transformer may also supply other AC auxiliary power requirements for the switchgear.

For DC control, it would require a DC control battery, battery charger and an AC auxiliary power source for the battery charger. The battery provides a very reliable DC control source, since it is isolated from the AC power system by the battery charger. However, the battery will require periodic routine maintenance and battery capacity is reduced by low ambient temperature.

Any economic comparison of AC and DC control for switchgear should consider that the AC capacitor trip is a static device with negligible maintenance and long life, while the DC battery will require maintenance and replacement at some time in the future.

Relays

Microprocessor-based or solid-state relays would generally require DC power or reliable uninterruptible AC supply for their logic circuits.

Auxiliary Switches

Optional circuit breaker and cell auxiliary switches are available where needed for interlocking or control of auxiliary devices. Typical applications and operation are described in **Figure 5.4-7** and **Table 5.4-18**.

Breaker auxiliary switches and MOC switches are used for breaker open/close status and interlocking.

Auxiliary contacts available for controls or external use from auxiliary switch located on the circuit breaker are typically limited in number by the breaker control requirements as follows:

- Breakers with AC control voltage: 1NO and 3NC
- Breakers with DC control voltage: 2NO and 3NC

When additional auxiliary contacts are needed, following options are available:

- 5/15/27 kV Breakers: Each breaker compartment can be provided with up to three Mechanism Operated Cell (MOC) switches, each with 5NO and 4NC contacts. The MOC switches are rotary switches, mounted in the cell, and operated by a plunger on the breaker. Two types of MOC switches can be provided—MOC that operates with breaker in connected position only, or MOC that operates with breaker in connected, as well as test position
- 38 kV Breakers: Each 38 kV breaker can be provided with an additional breaker mounted auxiliary switch, with 5 NO and 5 NC contacts

Another optional switch available is called TOC–Truck Operated Switch. This switch is mounted in the cell and operates when the circuit breaker is levered into or out of the operating position. This switch changes its state when breaker is moved from test to connected position and vice versa. The TOC provides 4NO and 5NC contacts.

Auxiliary switch contacts are primarily used to provide interlocking in control circuits, switch indicating lights, auxiliary relays or other small loads. Suitability for switching remote auxiliary devices, such as motor heaters or solenoids, may be checked with the interrupting capacity listed in **Table 5.4-18**. Where higher interrupting capacities are required, an interposing contactor should be specified.

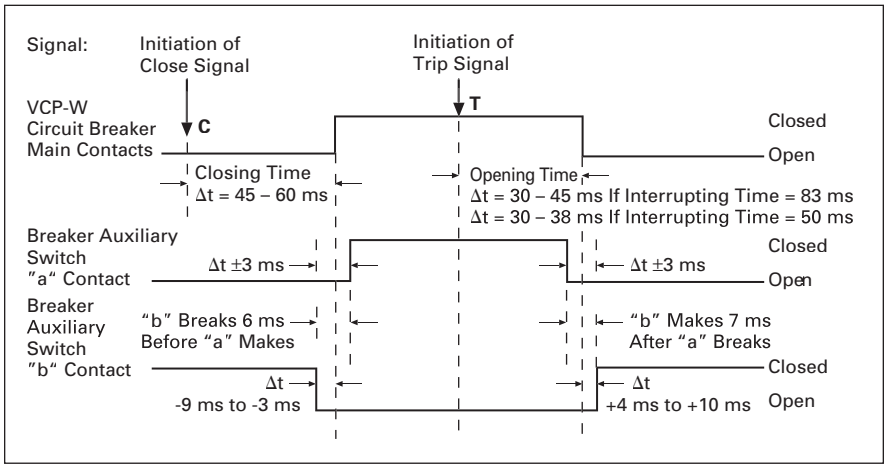


Figure 5.4-7. Breaker Auxiliary Switch Operating Times

Table 5.4-18. Auxiliary Switch Contacts Interrupting Capacities

Type Auxiliary Switch	Continuous Current Amperes	Control Circuit Voltage				
		120 Vac	240 Vac	48 Vdc	125 Vdc	250 Vdc
Non-inductive Circuit Interrupting Capacity in Amperes						
Breaker Auxiliary Switch	20	15	10	16	10	5
TOC Switch	20	15	10	16	10	5
MOC Switch	20	15	10	16	10	5
Inductive Circuit Interrupting Capacity in Amperes						
Breaker Auxiliary Switch	20	15	10	16	10	5
TOC Switch	20	15	10	16	10	5
MOC Switch	20	15	10	16	10	5

Table 5.4-19. 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

Table 5.4-20. Control Power Transformers—Single-Phase, 60 Hz ①

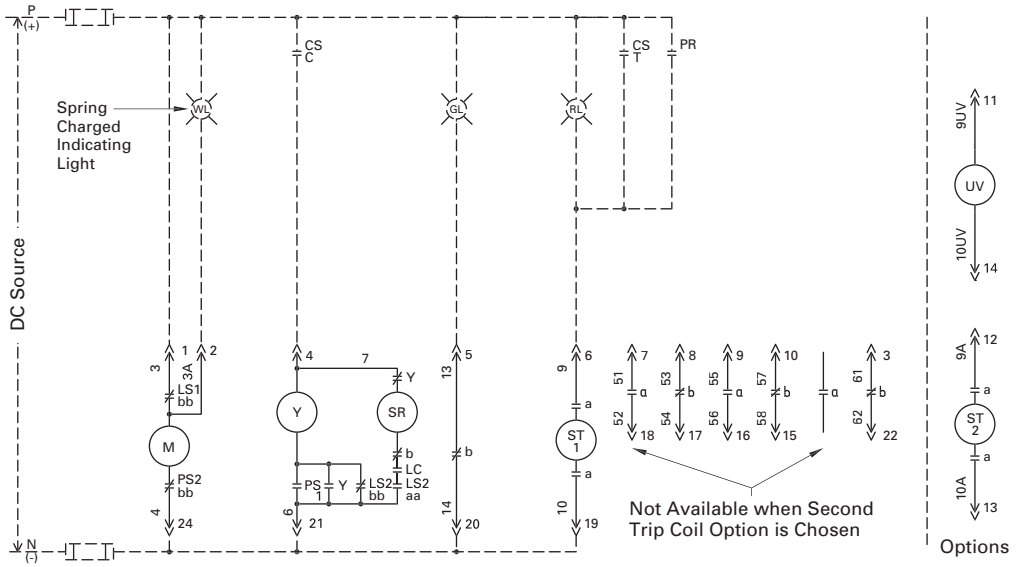
Taps			Secondary Volts	kVA	kV Class
+7-1/2%	Rated	–7-1/2%			
2580	2400	2220	240/120	5, 10, 15	5
4470	4160	3850	240/120	5, 10, 15	5
5160	4800	4400	240/120	5, 10, 15	5
7740	7200	6680	240/120	5, 10, 15	15
9030	8400	7770	240/120	5, 10, 15	15
13405	12470	11535	240/120	5, 10, 15	15
14190	13200	12210	240/120	5, 10, 15	15
14835	13800	12765	240/120	5, 10, 15	15
24725	23000	21275	240/120	5, 10, 15	27
37088	34500	31913	240/120	15, 25	38 ②

① Line-to-line connection only available. Refer to Eaton for other voltages and kVA ratings.
② 150 kV BIL.

5

5

ANSI Standard VCP-W Breaker DC Control Schematic



ANSI Standard VCP-W Breaker AC Control Schematic

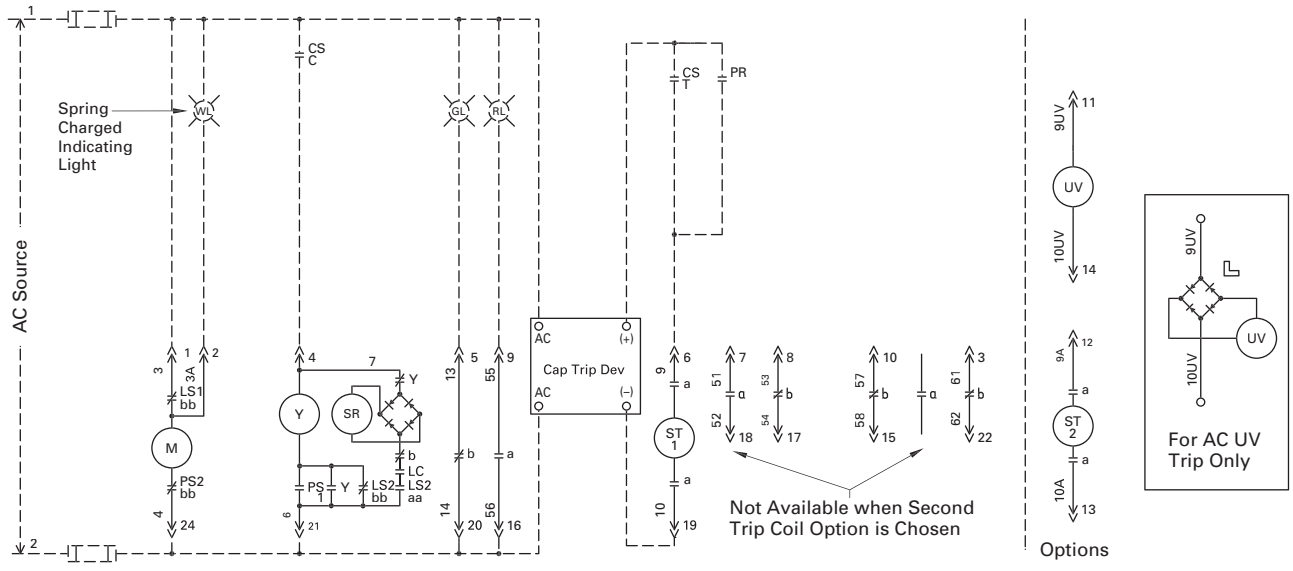


Figure 5.4-8. Typical 5/15/27 kV VCP-W "DC" and "AC" Control Schematics

Legend:
- **CS C** = Breaker Control Switch–Close
- **CS 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 aa** = Open until springs are fully charged.
- **LS1 bb** = Closed until springs are fully charged.
- **LS2 aa** = Open until springs are fully charged.
- **LS2 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.

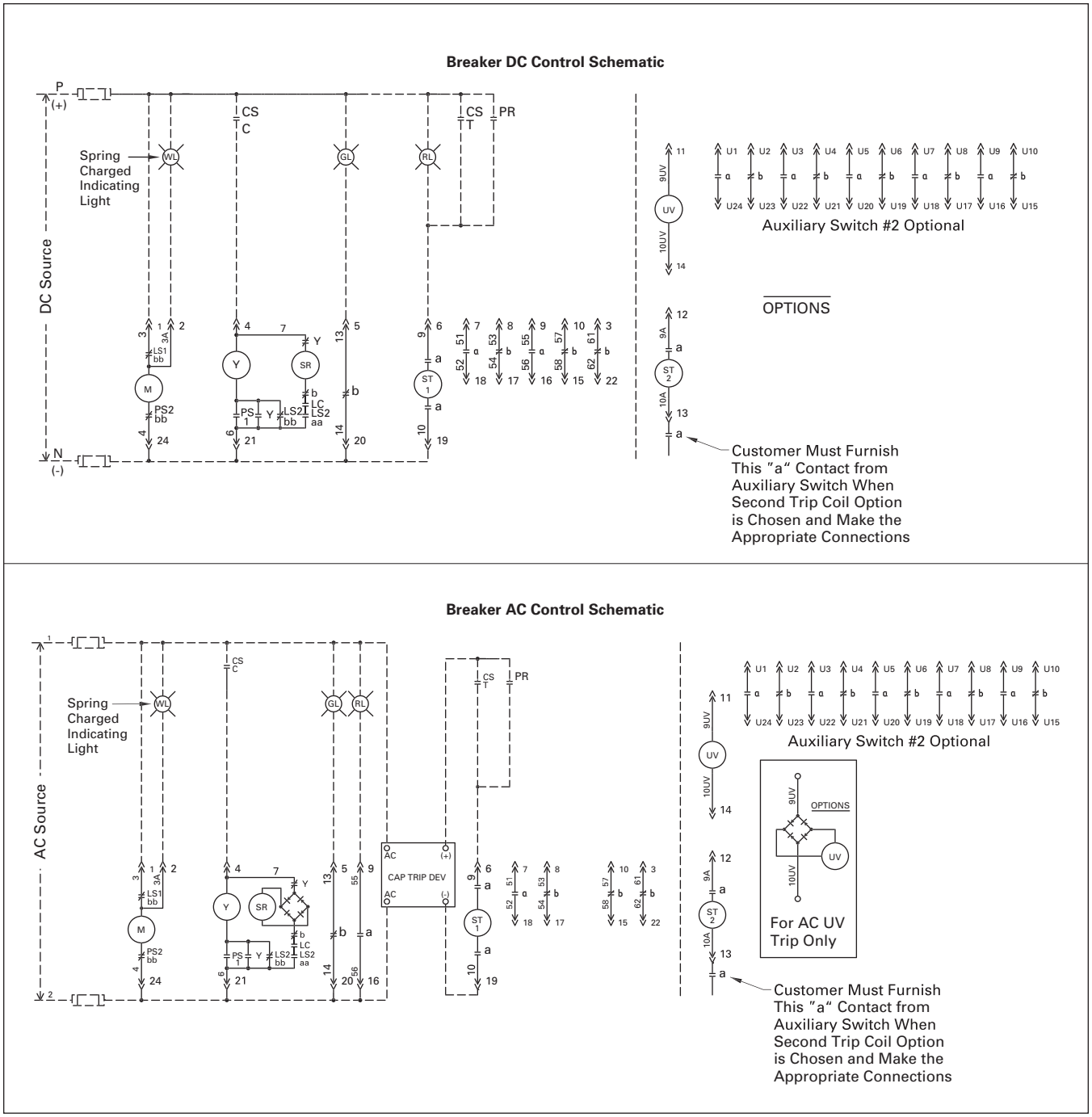


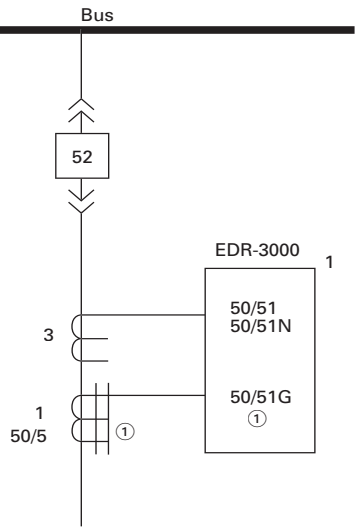
Figure 5.4-9. Typical 38 kV VCP-W "DC" and "AC" Control Schematics

Legend:

CS C = Breaker Control Switch–Close
CS 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

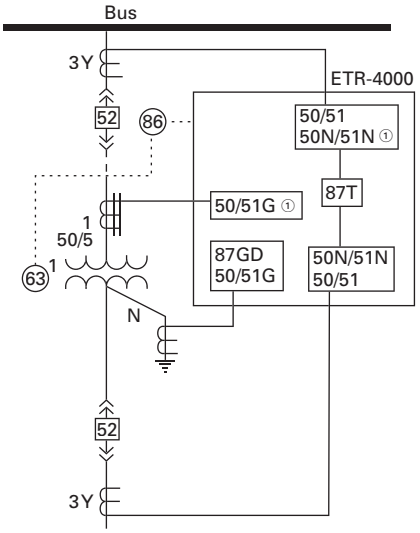
Operation:

LS1 aa = Open until springs are fully charged.
LS1 bb = Closed until springs are fully charged.
LS2 aa = Open until springs are fully charged.
LS2 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.



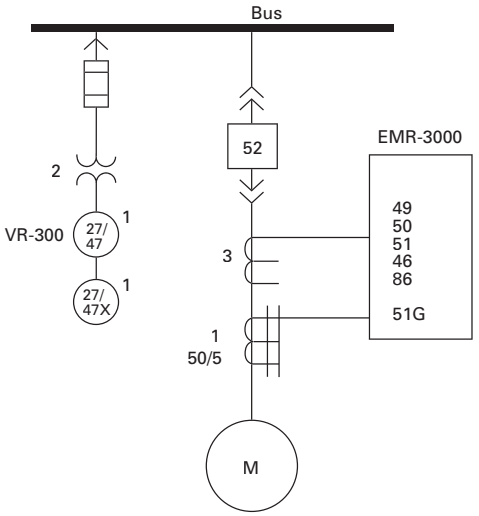
Phase CT Rating = 200% Feeder Full Load
EDR-3000 = Eaton Distribution Relay
① Alternate to 50/51N

Figure 5.4-10. Protective Relays—Feeder Circuit



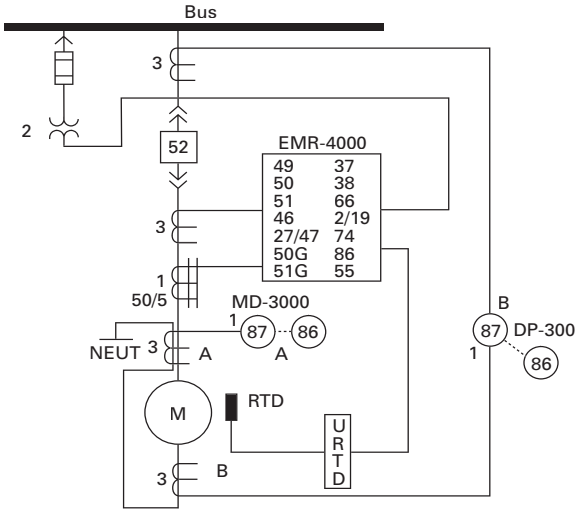
Phase CT Rating = 200% Full Load
ETR-4000 = Eaton Transformer Relay
87T–Transformer Differential Relay (Above 5 MVA)
86GD = Ground Differential Relay (Above 5 MVA and Low Resistance Grounded)
86–Lockout Relay
63–Sudden Pressure Relay (Liquid Above 5 MVA)
① Alternate to 50/51N

Figure 5.4-12. Protective Relays—Transformer Feeder



Phase CT Rating = 150% Full Load
EMR-3000 = Eaton Motor Relay
27/47–Undervoltage, Phase Sequence, and Unbalanced Voltage Relay
VR-300 (One Per Bus)
27/47x–Auxiliary Relay for Multi-motor System

Figure 5.4-11. Protective Relays—Induction Motors Below 1500 hp Minimum Adequate Protection



Phase CT Rating = 150% Full Load
A–Preferred Scheme (MD-3000 = Self-Balancing Differential Scheme)
B–Alternate Scheme (DP-300 = Restrained Differential Scheme)
EMR-4000 = Eaton Motor Relay
87–Motor Differential Relay
86–Lockout Relay
55–Loss of Synchronism (Synchronous Motors Only)
URTD–Universal RTD Interface Module

Figure 5.4-13. Protective Relays—Induction Motors Above 1500 hp and Synchronous Motors

EDR-4000 Relay–Typical One-Line Diagrams

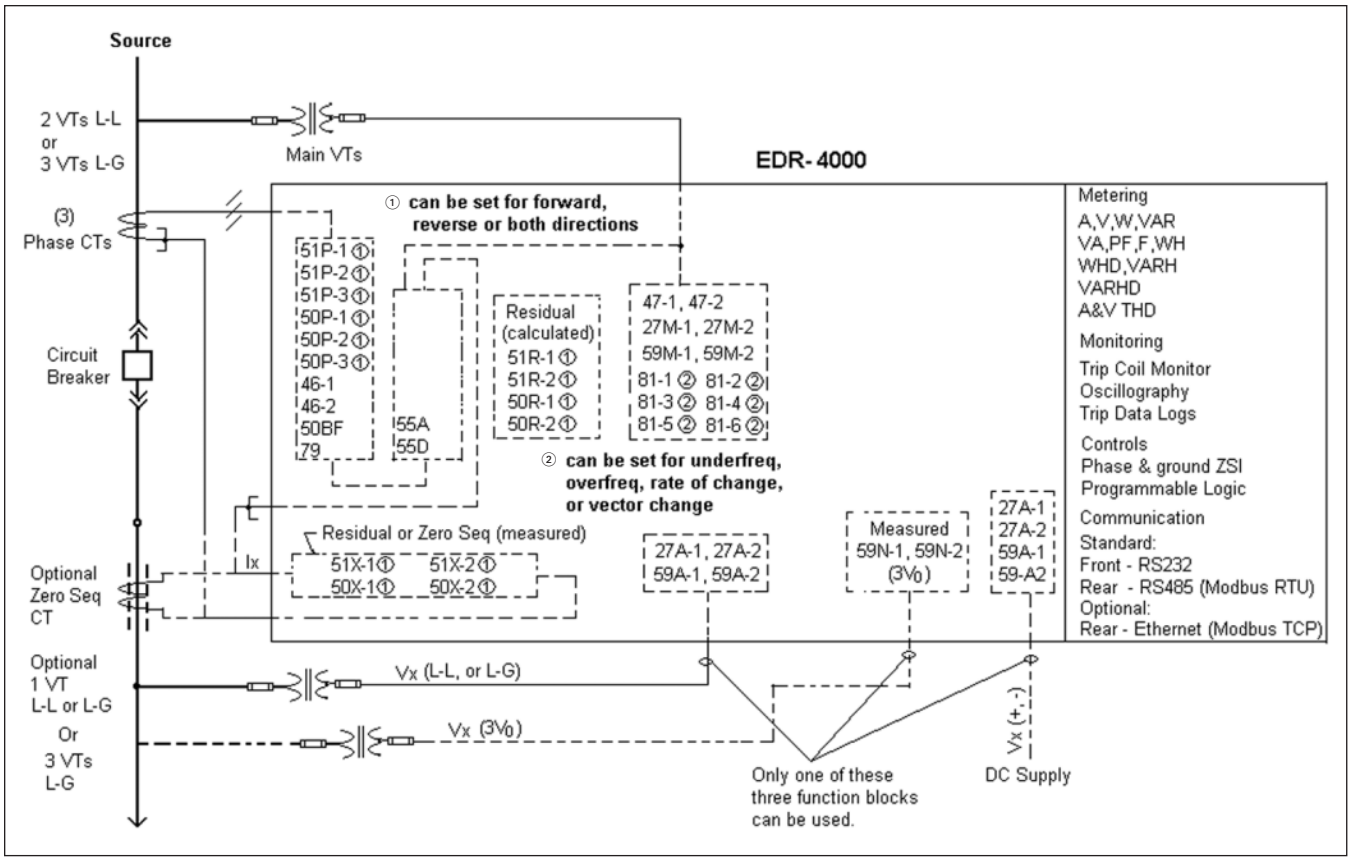


Figure 5.4-14. EDR-4000 Eaton Distribution Relay—Typical Main or Feeder Breaker Application Diagram

① Can be set for Forward, Reverse or Both directions.
② Can be Set for Underfreq, Overfreq, Rate of Change or Vector Change.

EDR-5000 Relay–Typical One-Line Diagrams

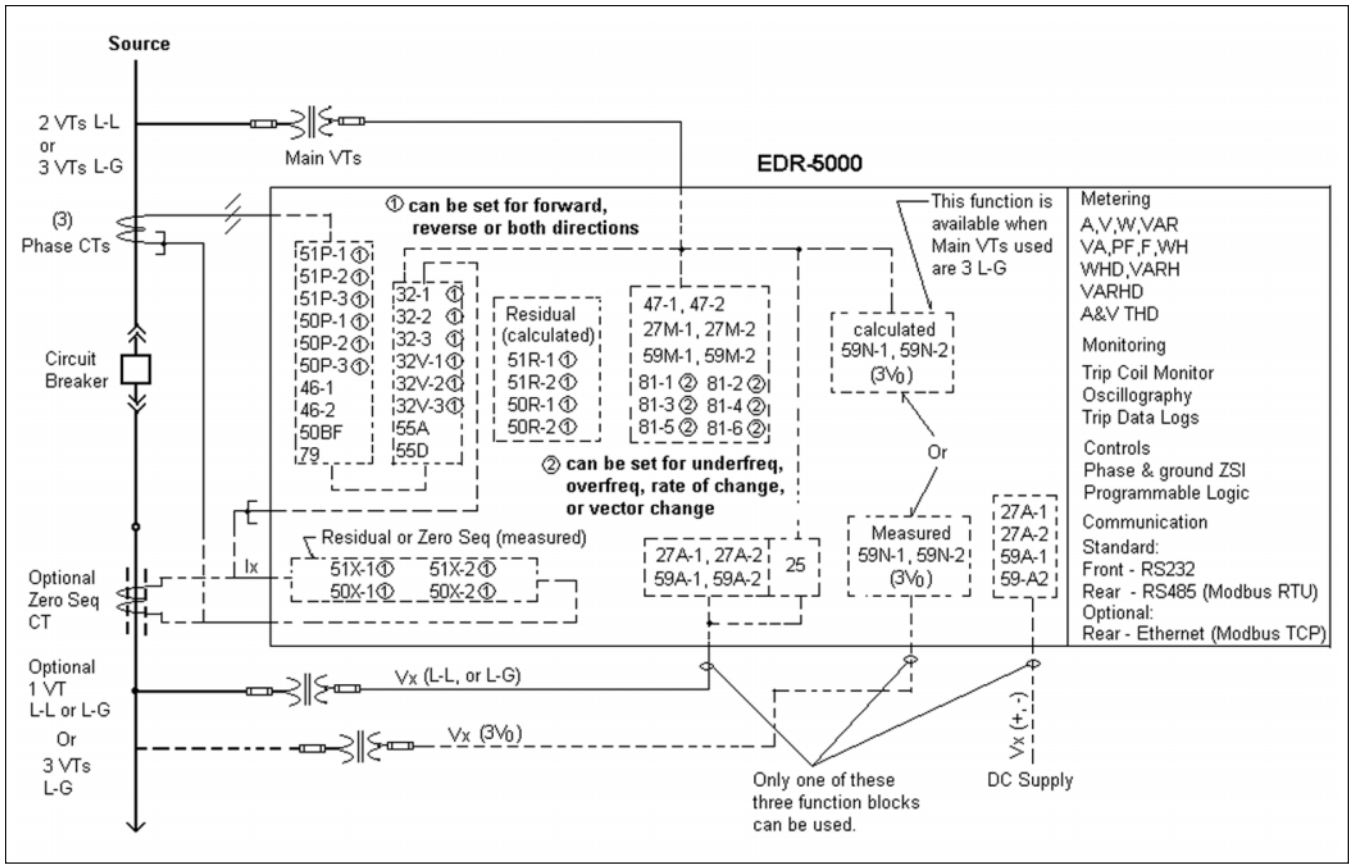


Figure 5.4-15. EDR-5000 Eaton Distribution Relay—Typical Main or Feeder Breaker Application Diagram

① Can be set for Forward, Reverse or Both directions.
② Can be Set for Underfreq, Overfreq, Rate of Change or Vector Change.

Refer to **Tab 4** for details on Eaton's relays. Refer to **Tab 3** for details on Eaton's available metering.

Typical Main-Tie-Main Arrangements (Standard Metal-Clad)

Note: Arrangements shown in **Figures 5.4-16–5.4-18** can be provided in 26.00-inch (660.4 mm) wide, 95.00-inch (2413.0 mm) high, 96.25-inch (2444.8 mm) deep structures with 50VCPWND, 1200A circuit breakers.

Note: R = Multi-function relay, M = Multi-function meter.

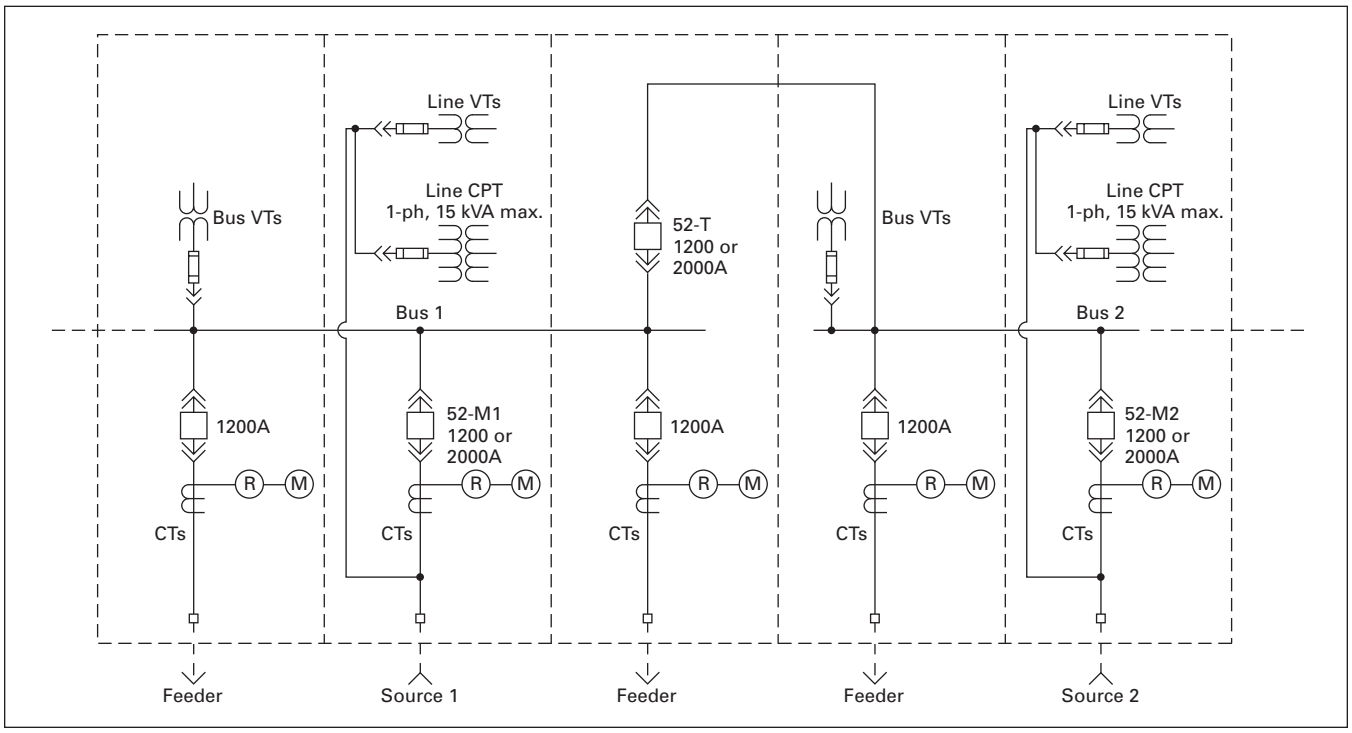


Figure 5.4-16. Typical Main-Tie-Main Arrangement with Bus and Line VTs and Line CPTs
5 or 15 kV VCP-W Switchgear, 1200 or 2000A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures

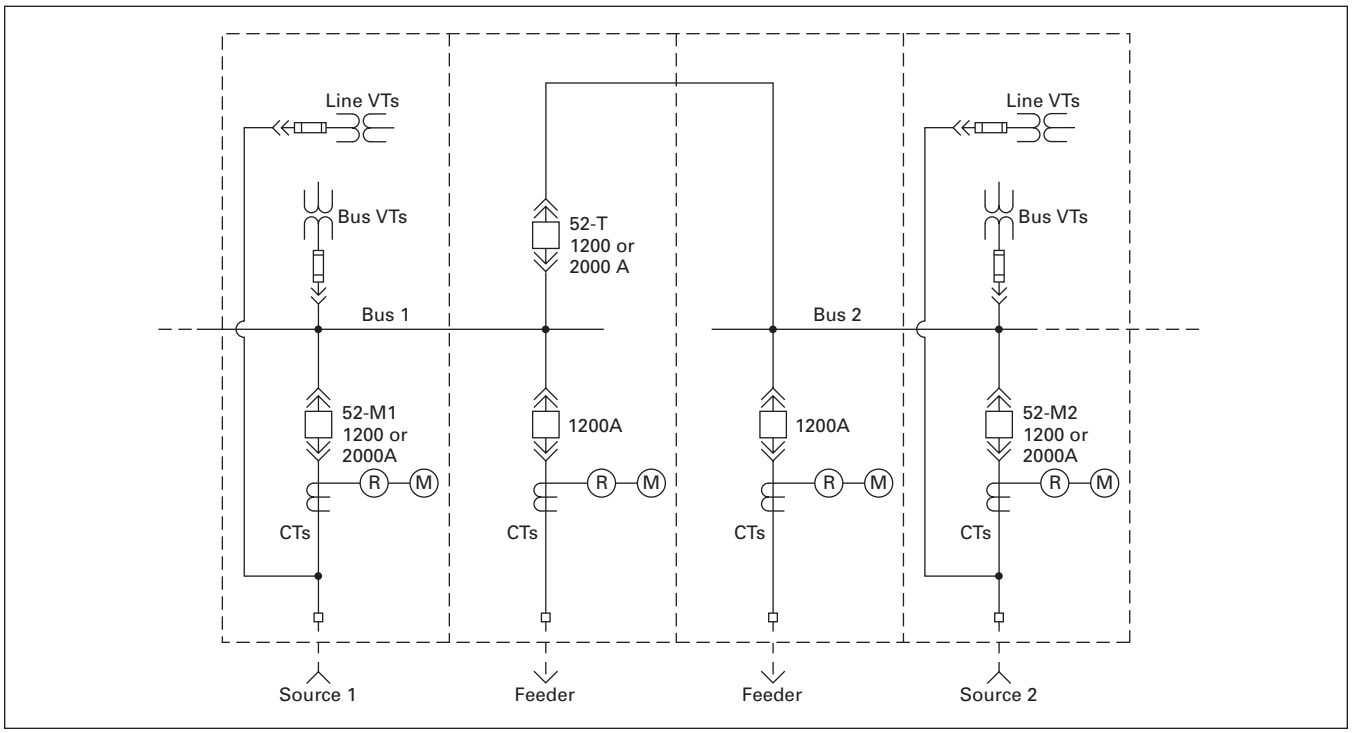


Figure 5.4-17. Typical Main-Tie-Main Arrangement with Bus and Line VTs, but without Line CPTs—Preferred Arrangement
5 or 15 kV VCP-W Switchgear, 1200 or 2000A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures

Typical Main-Tie-Main Arrangements (Continued)

Note: R = Multi-function relay, M = Multi-function meter

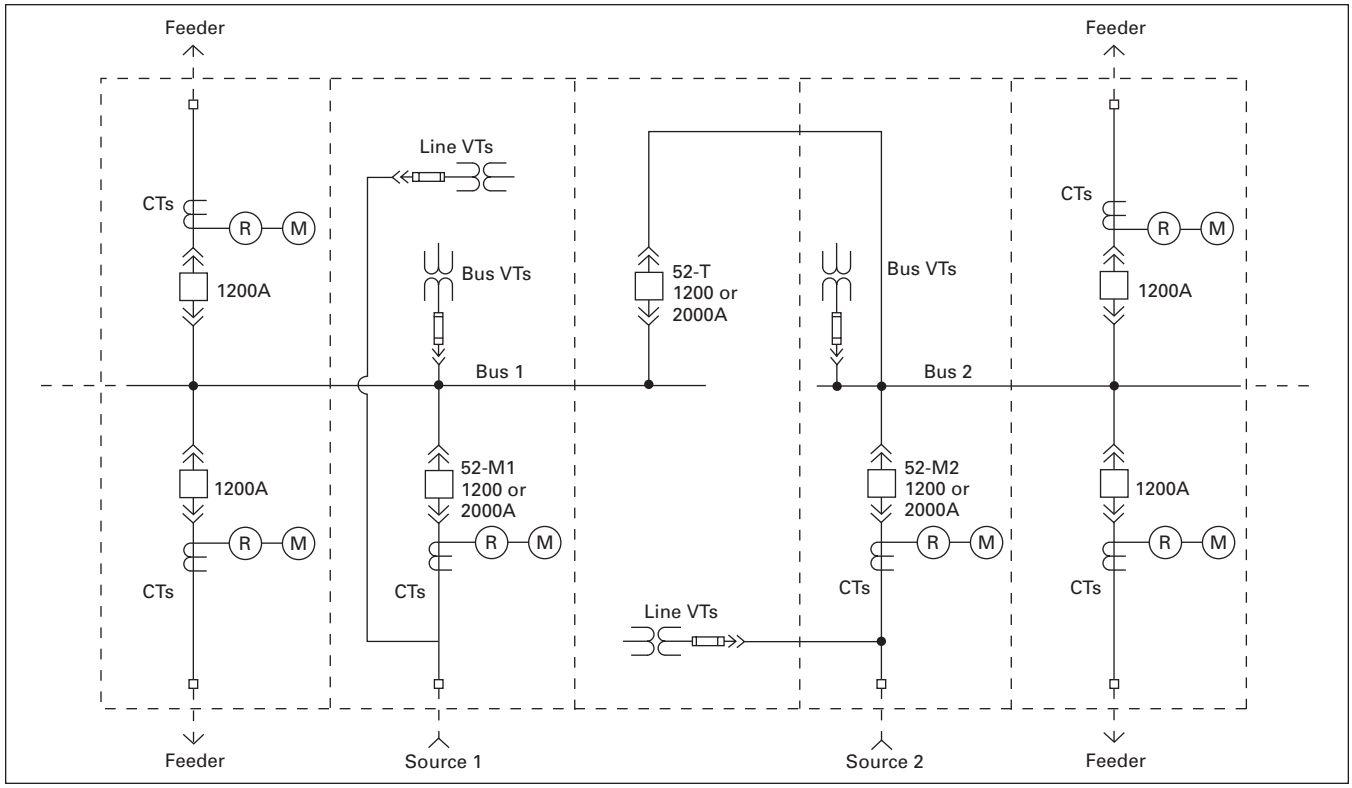


Figure 5.4-18. Typical Main-Tie-Main Arrangement with Bus and Line VTs, but without Line CPTs—Alternate Arrangement 5 or 15 kV VCP-W Switchgear, 1200 or 2000A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures

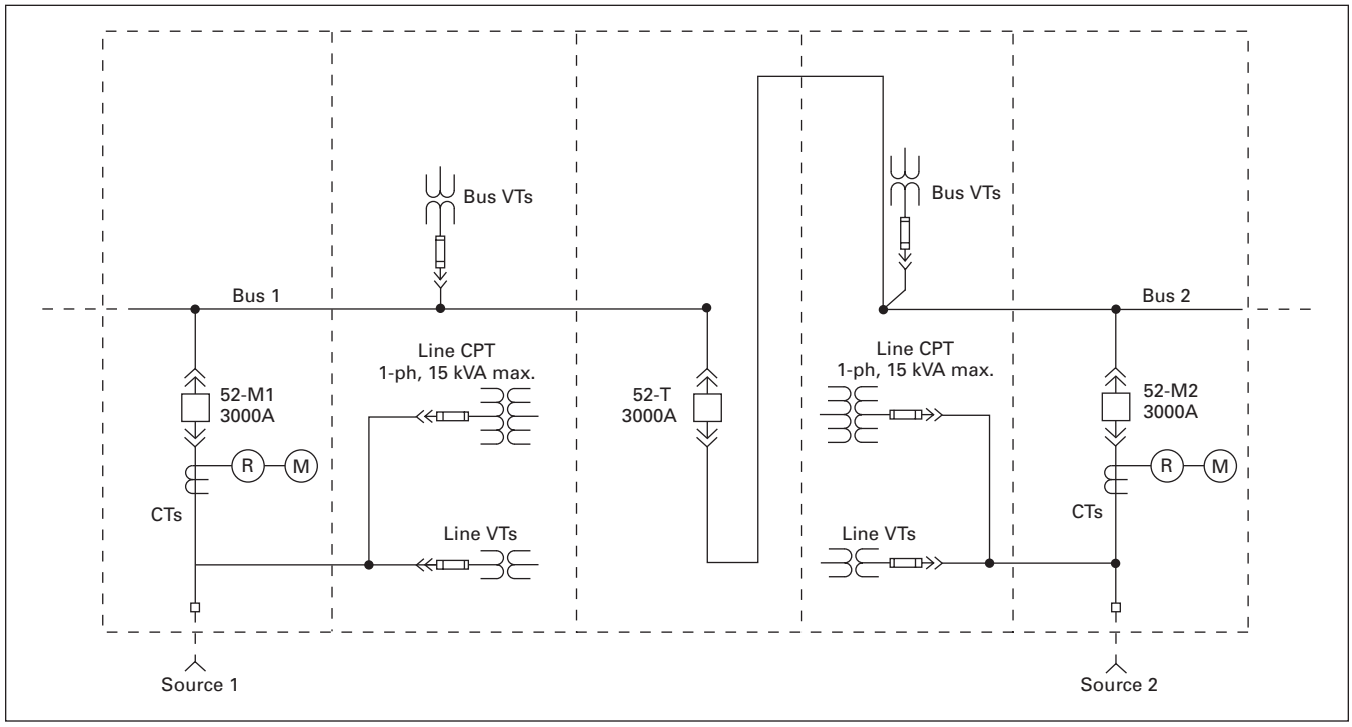


Figure 5.4-19. Typical Main-Tie-Main Arrangement with Bus and Line VTs, and Line CPTs 5 or 15 kV VCP-W Switchgear, 3000A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures

Typical Main-Tie-Main Arrangements (Continued)

Note: R = Multi-function relay, M = Multi-function meter

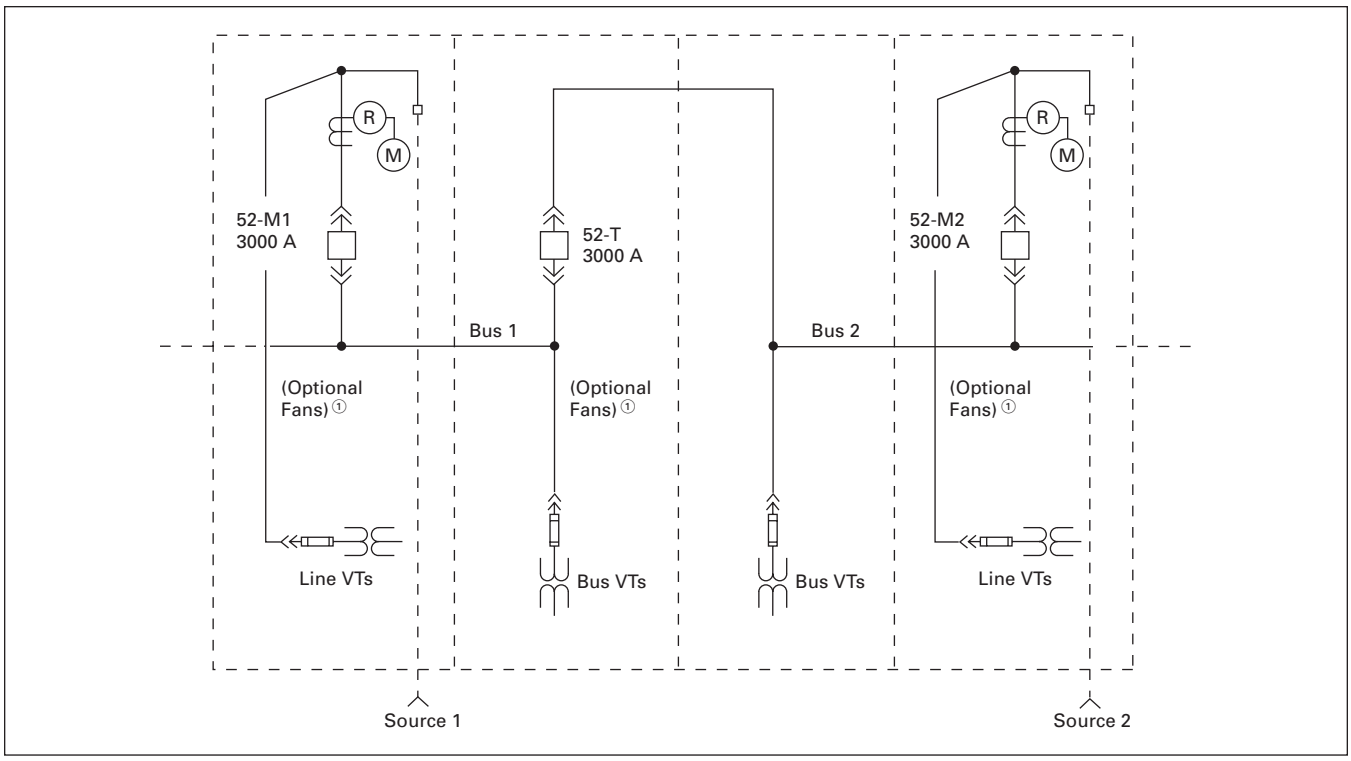


Figure 5.4-20. Typical Main-Tie-Main Arrangement with Bus and Line VTs
5 or 15 kV VCP-W Switchgear, 3000A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures

① This arrangement can be supplied with cooling fans to allow 4000A continuous.

Medium Voltage High Resistance Grounding System

Refer to **Tab 36, Section 36.1**, for complete product description, single-line diagram, layout and dimensions of medium voltage high resistance grounding system.

5

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Layout Dimensions—5 and 15 kV—Dimensions in Inches (mm)

Typical Units

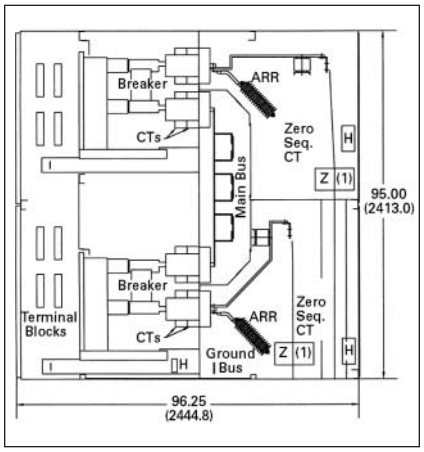

Figure 5.5-1. 36.00-Inch (914.4 mm) Wide Typical Breaker/Breaker Vertical Section

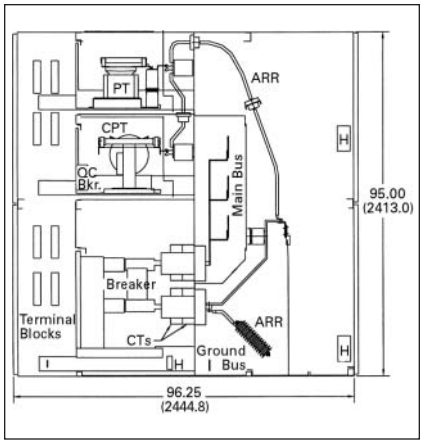

Figure 5.5-2. 36.00-Inch (914.4 mm) Wide Typical Auxiliary/Breaker Vertical Section

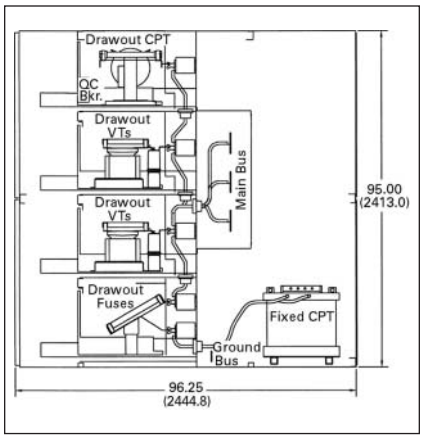

Figure 5.5-3. 36.00-Inch (914.4 mm) Wide Typical Auxiliary/Auxiliary Vertical Section

Tie Breaker Bus Transition Requirements

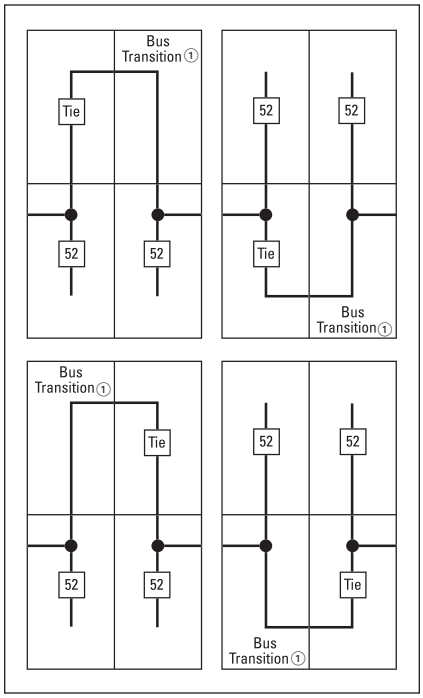

Figure 5.5-4. Tie Breaker Bus Transition Requirements

① Breakers cannot be located in bus transition compartment.

Available Configurations

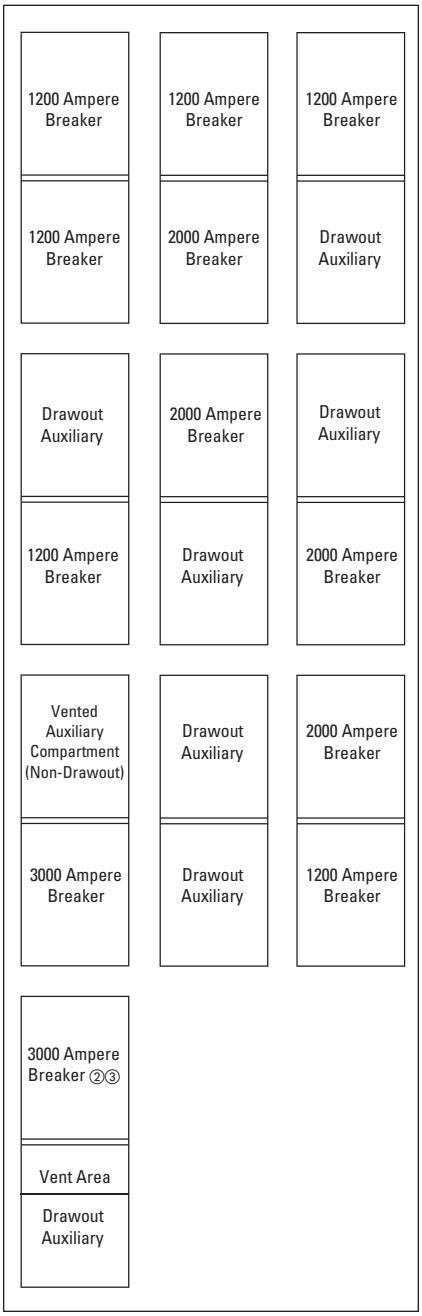

Figure 5.5-5. Available Configurations

② For 4000A force cooled application, refer to Eaton.

③ This configuration is available for indoor and outdoor walk-in designs only.

Dimensions for estimating purposes only.

Typical Weights in Lbs (kg)

Table 5.5-1. Assemblies (Less Breakers. See Table 5.5-2 for Breakers.) ①

Type of Vertical Section	Main Bus Rating Amperes	Indoor	Aisleless	Sheltered-Aisle Including Aisle	
				Single Row	Double Row
B/B	1200 2000 3000 4000	2400 (1090) 2500 (1135) 2600 (1180) 2700 (1226)	3200 (1453) 3300 (1500) 3400 (1545) 3500 (1590)	4200 (1907) 4300 (1952) 4400 (1998) 4500 (2045)	7200 (3269) 7400 (3360) 7600 (3450) 7700 (3500)
B/A or A/B	1200 2000 3000 4000	2300 (1044) 2400 (1090) 2500 (1135) 2600 (1180)	2900 (1317) 3000 (1362) 3100 (1407) 3200 (1453)	4100 (1861) 4200 (1907) 4300 (1952) 4400 (1998)	7000 (3178) 7200 (3269) 7400 (3360) 7500 (3409)
A/A	1200 2000 3000 4000	2000 (908) 2100 (953) 2200 (999) 2300 (1046)	2600 (1180) 2700 (1226) 2800 (1271) 2900 (1317)	3800 (1725) 3900 (1771) 4000 (1816) 4100 (1861)	6400 (2906) 6600 (2996) 6800 (3087) 6900 (3136)

① See **Table 5.5-2** for breakers.

5

Table 5.5-2. Breaker Weights in Lbs (kg)

Type of Breaker	Current Rating, Amperes		
	1200	2000	3000
	Approximate Weight, Lbs (kg), Static ②		
50 VCP-W 250, 40C, 25, 40 50 VCP-W 350, 50C, 50 50 VCP-W 500, 63C, 63	350 (159) 460 (209) 575 (261)	410 (186) 490 (222) 575 (261)	525 (238) 525 (238) 575 (261)
75 VCP-W 500, 50C, 50 150 VCP-W 500, 25C, 25 150 VCP-W 750, 40C, 40	375 (170) 350 (159) 350 (159)	410 (186) 410 (186) 410 (186)	525 (238) 525 (238) 525 (238)
150 VCP-W 1000, 50C, 50 150 VCP-W 1500, 63C, 63	460 (209) 575 (261)	490 (222) 575 (261)	525 (238) 575 (261)

② Impact weight = 1.5 times static weight.

Dimensions in Inches (mm)

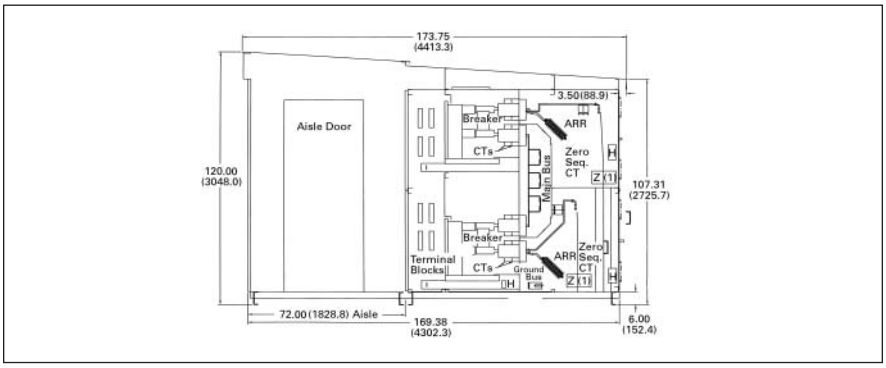

Figure 5.5-6. Outdoor Sheltered Aisle Single Row

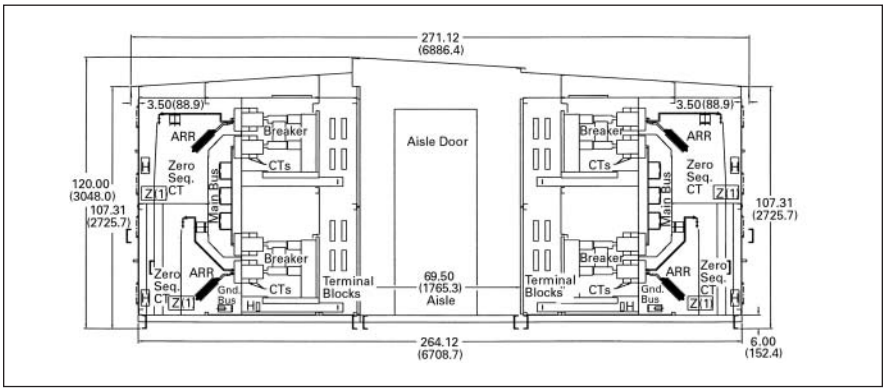

Figure 5.5-7. Outdoor Sheltered Aisle Double Row

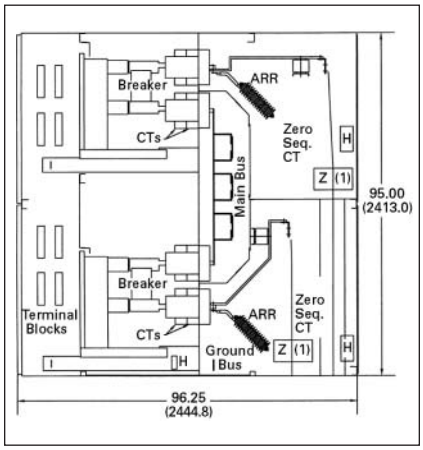

Figure 5.5-8. Indoor

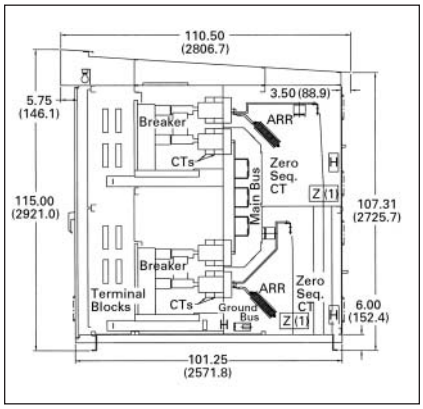

Figure 5.5-9. Outdoor Aisleless

Dimensions and weights for estimating purposes only.

Dimensions in Inches (mm) (Continued)

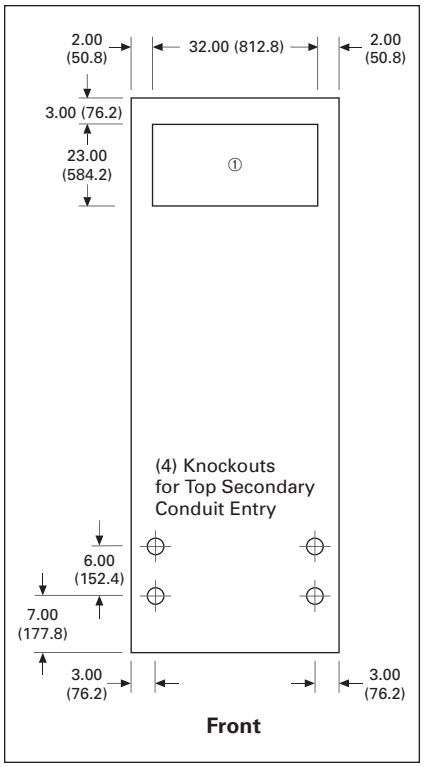

Figure 5.5-10. Top View of Typical Indoor Breaker and Auxiliary Structures

① Primary conduit locations for top or bottom entry.

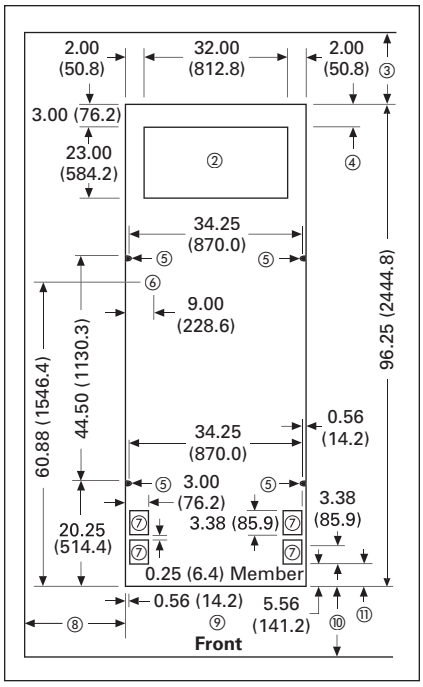

Figure 5.5-11. Base Plan of a Typical Indoor Breaker or Auxiliary Structure

② Primary conduit locations for top or bottom entry.
③ Recommended minimum clearance to rear of VacClad-W: 36.00 inches (914.4 mm).
④ Floor steel, if used, must not exceed 3.25 inches (82.6 mm) under VacClad-W.
⑤ Anchor locations: indoor—0.50-inch (12.7 mm) bolts or weld, outdoor—0.50-inch (12.7 mm) bolts.
⑥ Station ground connection provision.
⑦ Secondary conduit space: All—maximum of 1.00-inch (25.4 mm) projection.
⑧ Minimum clearance to LH side of VacClad-W: 32.00 inches (812.8 mm).
⑨ Finished foundation surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back, and diagonally, as measured by a laser level.
⑩ Minimum clearance to front of VacClad-W: 70.00 inches (1778.0 mm).
⑪ Floor steel if used, must not exceed this dimension under VacClad-W.

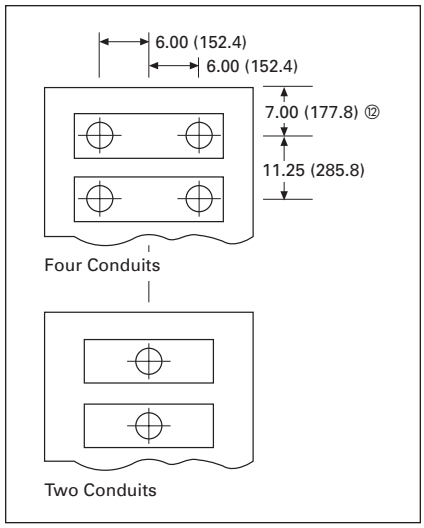

Figure 5.5-12. Primary Conduit Locations for Top or Bottom Entry

⑫ Changes to 8.25 (209.6 mm) if optional hinged rear doors are required.

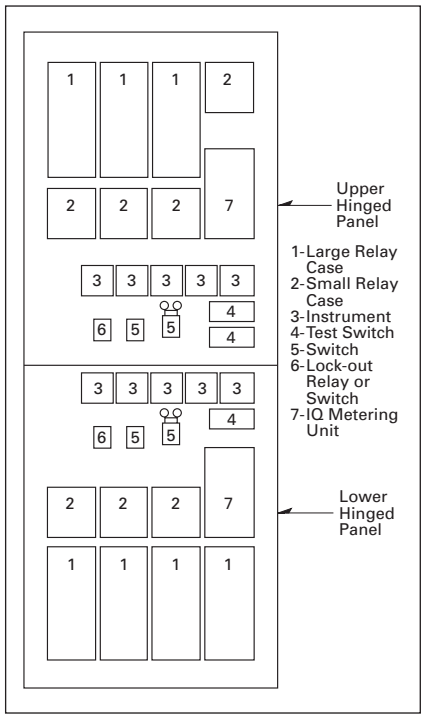

Figure 5.5-13. Maximum Hinged Panel Equipment

Note: The figure above shows that the arrangement of components differs between upper and lower panels. The figure may also be used to select custom arrangements of hinged panel components. Also, the use of multi-purpose solid-state relays such as Eaton's Digitrip 3000 (same size as 7) will significantly reduce consumption of panel space.

Dimensions for estimating purposes only.

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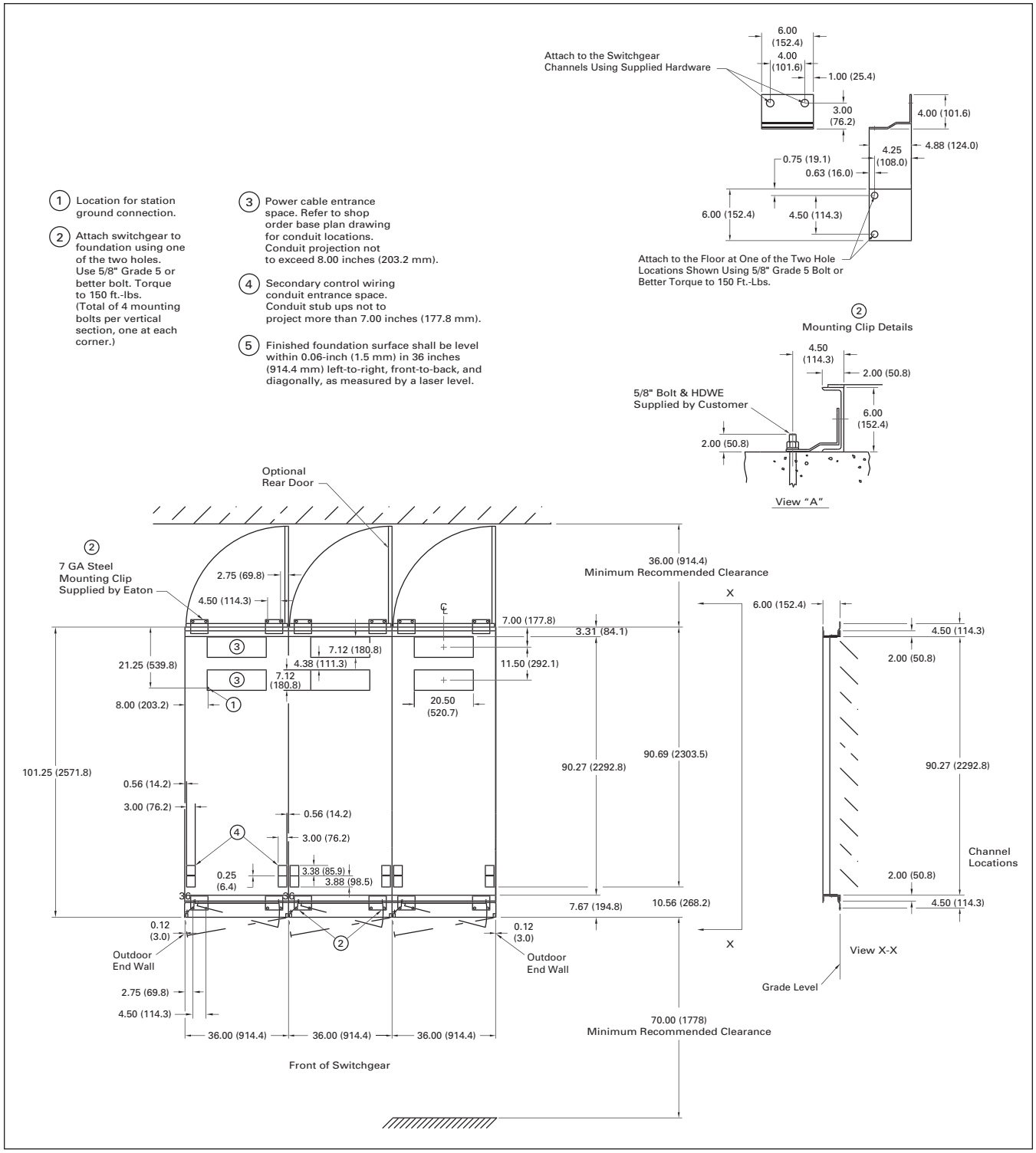


Figure 5.5-14. 5/15 kV Switchgear Outdoor Aisleless Base Plan (Typical Details)—Dimensions in Inches (mm)

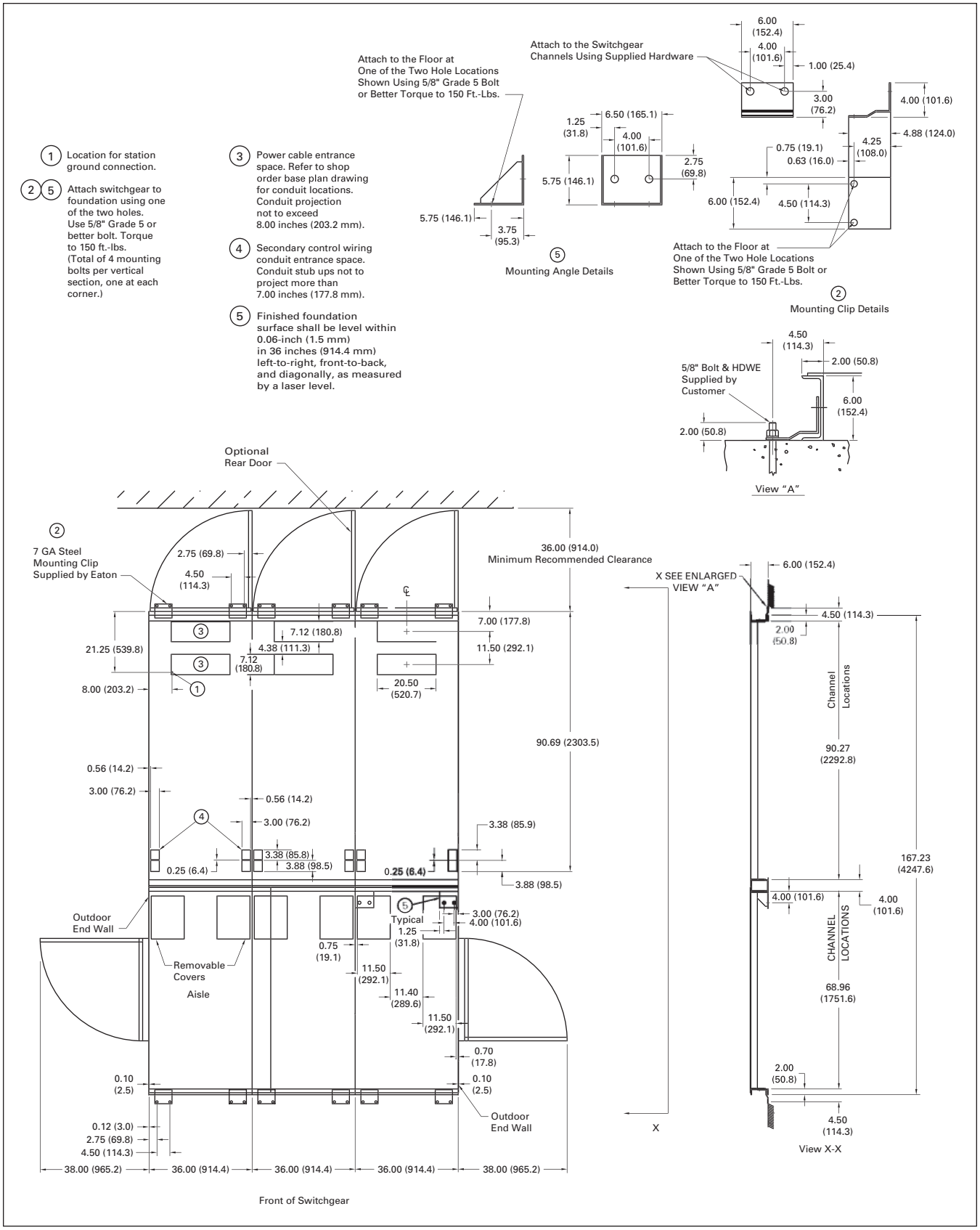


Figure 5.5-15. 5/15 kV Switchgear Outdoor Sheltered Aisle Base Plan (Typical Details)—Dimensions in Inches (mm)

Note:
First install both rows of switchgear then install aisle parts per drawing. (Later)

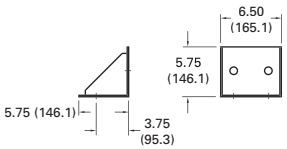
① Location for station ground connection typical each end unit.

②⑤ Attach switchgear to foundation using one of the two holes. Use 5/8" Grade 5 or better bolt. Torque to 150 ft. lbs. (Total of 4 mounting bolts per vertical section, one at each corner.)

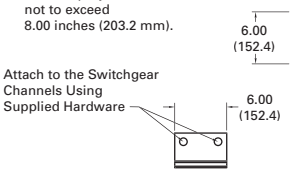
⑥ Finished foundation surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back, and diagonally, as measured by a laser level.

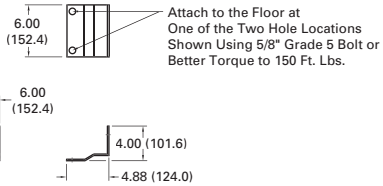
③ Power cable entrance space. Refer to shop order base plan drawing for conduit locations. Conduit projection not to exceed 8.00 inches (203.2 mm).

④ Secondary control wiring conduit entrance space. Conduit stub ups not to project more than 7.00 inches (177.8 mm).

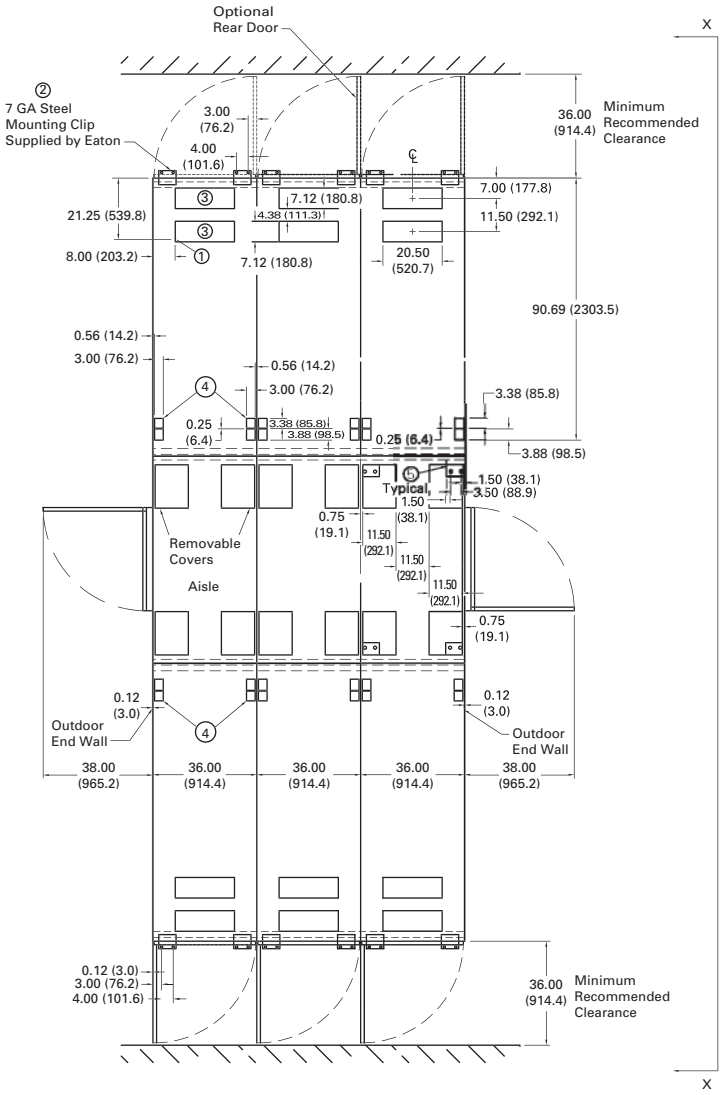


⑤ Mounting Angle Details





② Mounting Clip Details



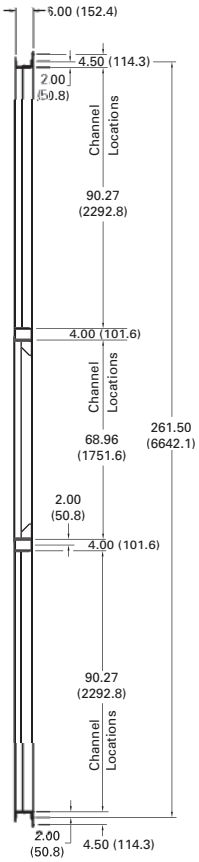


Figure 5.5-16. 5/15 kV Switchgear Outdoor Common Aisle Base Plan (Typical Details)—Dimensions in Inches (mm)

Layout Dimensions—5 kV—Dimensions in Inches (mm)

Typical Units—Indoor

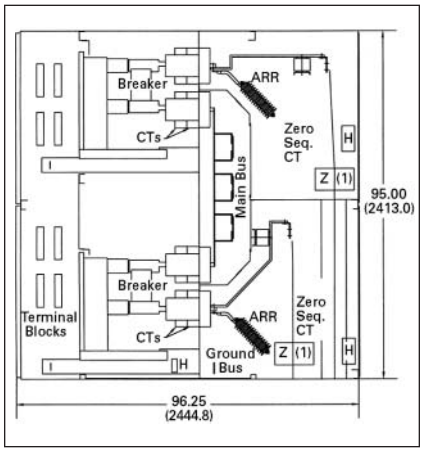


Figure 5.5-17. 26.00-Inch (660.4 mm) Wide Typical Breaker/Breaker Vertical Section

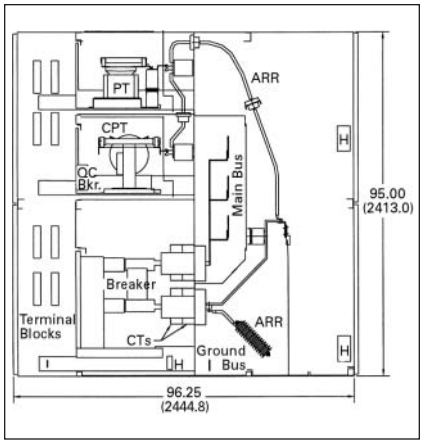


Figure 5.5-18. 26.00-Inch (660.4 mm) Wide Typical Auxiliary/Breaker Vertical Section

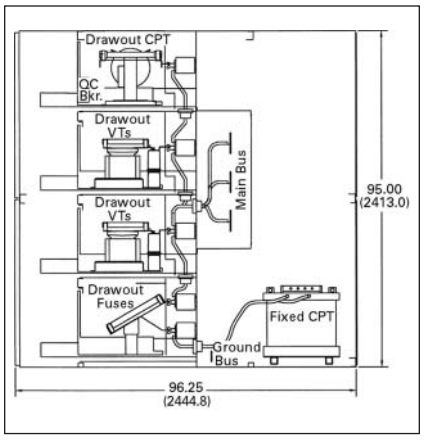


Figure 5.5-19. 26.00-Inch (660.4 mm) Wide Typical Auxiliary/Auxiliary Vertical Section

Tie Breaker Bus Transition Requirements

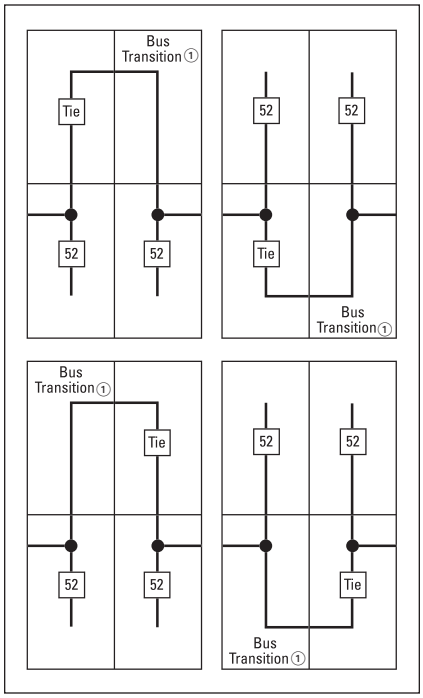


Figure 5.5-20. Tie Breaker Bus Transition Requirements

① Breakers cannot be located in bus transition compartment.

Available Configurations

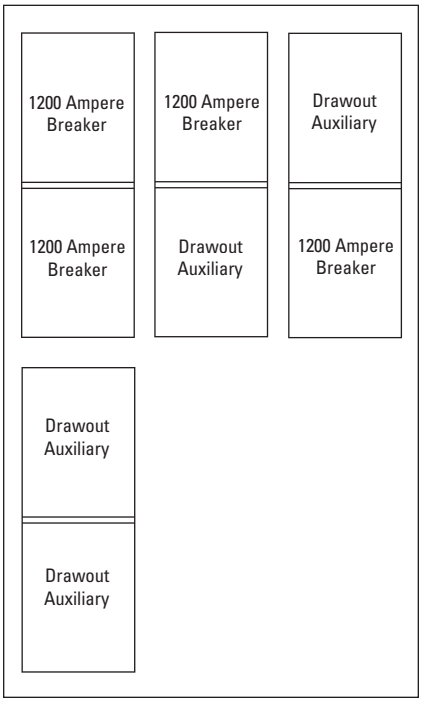


Figure 5.5-21. Available Configurations

Typical Weights

Table 5.5-3. Switchgear Assembly (Less Breaker)

Type of Vertical Section	Main Bus Rating, Amperes	Weight Lbs (kg)
B/B	1200 2000	2000 (908) 2200 (999)
B/A or A/B	1200 2000	1700 (772) 1900 (863)
A/A	1200 2000	1600 (726) 1800 (817)

Table 5.5-4. Circuit Breaker ②

Type of Circuit Breaker	Current Rating, Amperes	Weight Lbs (kg) (Static)
50 VCPW-ND-250	1200	345 (157)

② Breaker impact weight = 1.5 x static weight.

Dimensions for estimating purposes only.

Dimensions in Inches (mm) (Continued)

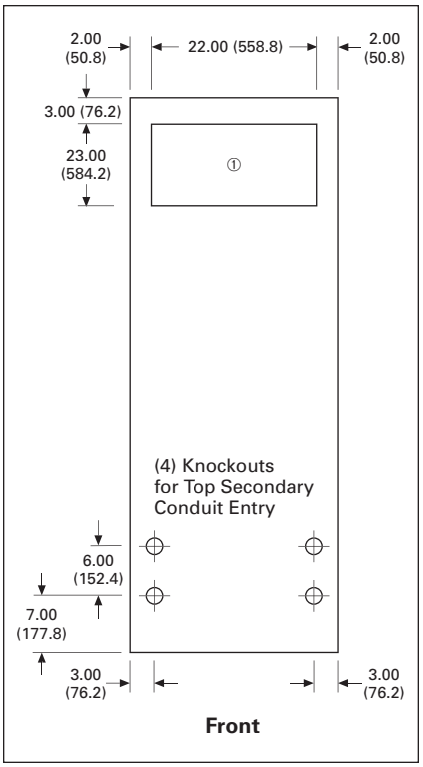


Figure 5.5-22. Top View of Typical Indoor Breaker and Auxiliary Structures

① Primary conduit locations for top or bottom entry.

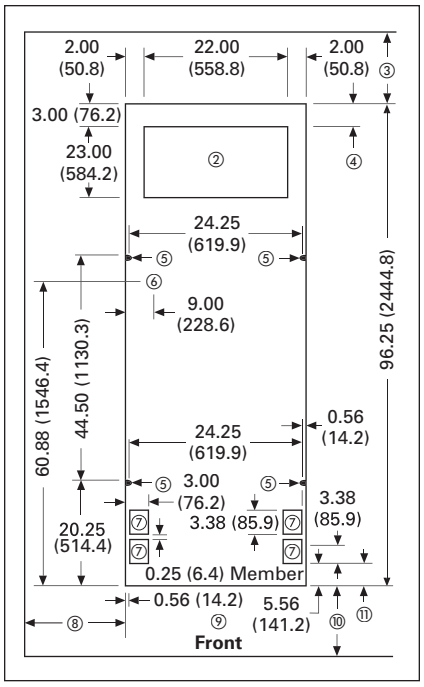


Figure 5.5-23. Base Plan of a Typical Indoor Breaker or Auxiliary Structure

② Primary conduit locations for top or bottom entry.
③ Recommended minimum clearance to rear of VacClad-W: 30.00 inches (762.0 mm).
④ Floor steel, if used, must not exceed 3.25 inches (82.6 mm) under VacClad-W.
⑤ Anchor locations: indoor–0.50-inch (12.7 mm) bolts or weld, outdoor–0.50-inch (12.7 mm) bolts.
⑥ Station ground connection provision.
⑦ Secondary conduit space: All–maximum of 1.00-inch (25.4 mm) projection.
⑧ Minimum clearance to LH side of VacClad-W: 26.00 inches (660.4 mm).
⑨ Finished foundation surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back, and diagonally, as measured by a laser level.
⑩ Minimum clearance to front of VacClad-W: 70.00 inches (1778.0 mm).
⑪ Floor steel if used, must not exceed this dimension under VacClad-W.

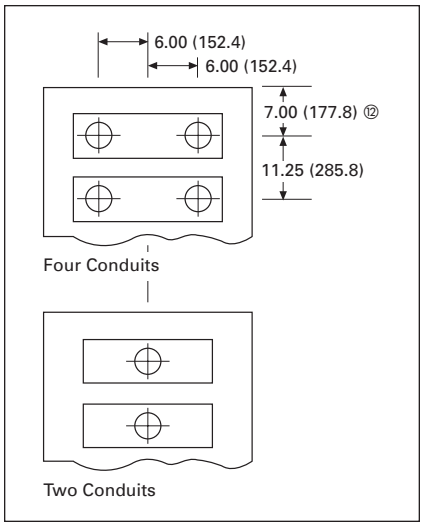


Figure 5.5-24. Primary Conduit Locations for Top or Bottom Entry

⑫ Changes to 8.25 (209.6 mm) if optional hinged rear doors are required.

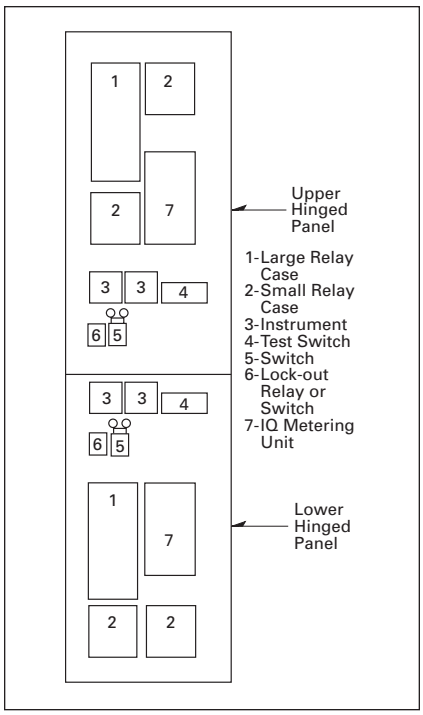


Figure 5.5-25. Maximum Hinged Panel Equipment

Note: The figure above shows that the arrangement of components differs between upper and lower panels. The figure may also be used to select custom arrangements of hinged panel components. Also, the use of multi-purpose solid-state relays such as Eaton's Digitrip 3000 (same size as 7) will significantly reduce consumption of panel space.

Dimensions for estimating purposes only.

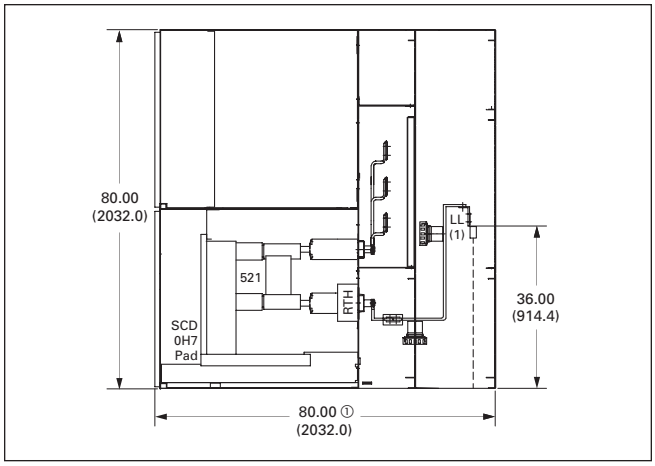


Figure 5.5-26. 5 kV, 1200A, 250 MVA VCP-W ND Low Profile 26.00-Inch (660.4 mm) Wide Indoor Unit, Blank/Breaker

① Depth can be reduced to 72.00 inches (1828.8 mm) if power cables enter from top.

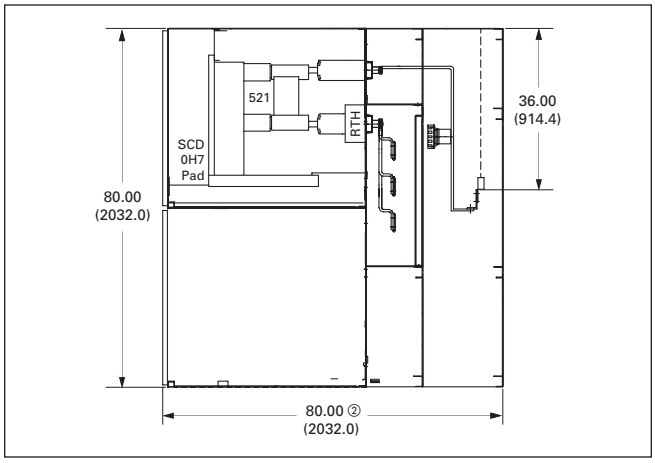


Figure 5.5-27. 5 kV, 1200A, 250 MVA VCP-W ND Low Profile 26.00-Inch (660.4 mm) Wide Indoor Unit, Breaker/Blank

② Depth can be reduced to 72.00 inches (1828.8 mm) if power cables enter from below.

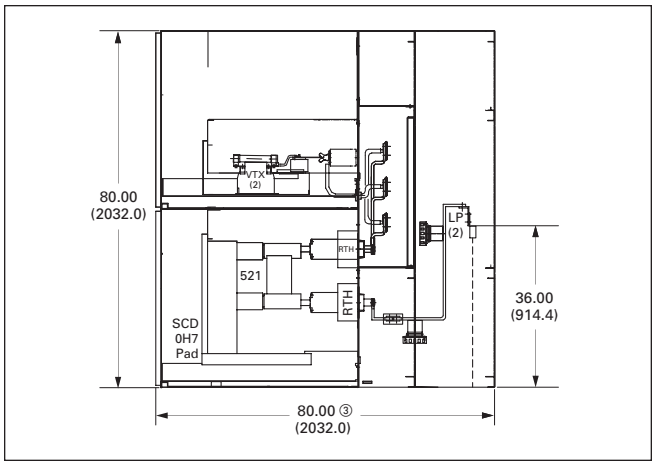


Figure 5.5-28. 5 kV, 1200A, 250 MVA VCP-W ND Low Profile 26.00-Inch (660.4 mm) Wide Indoor Unit, Auxiliary/Breaker

③ Depth can be reduced to 72.00 inch (1831.7 mm) if power cables enter from top.

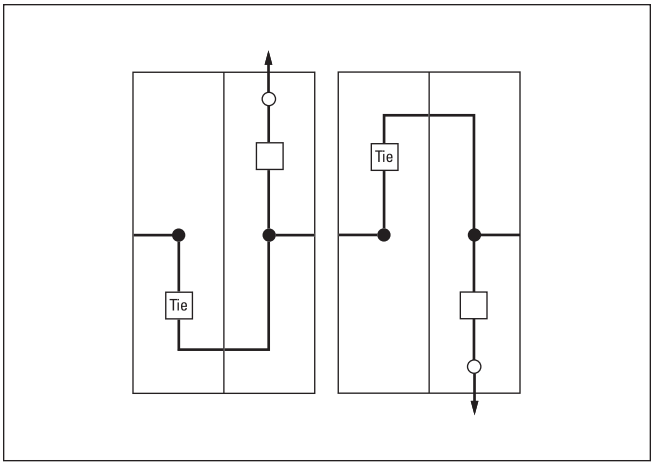


Figure 5.5-29. Tie Breaker Bus Transition Requirements

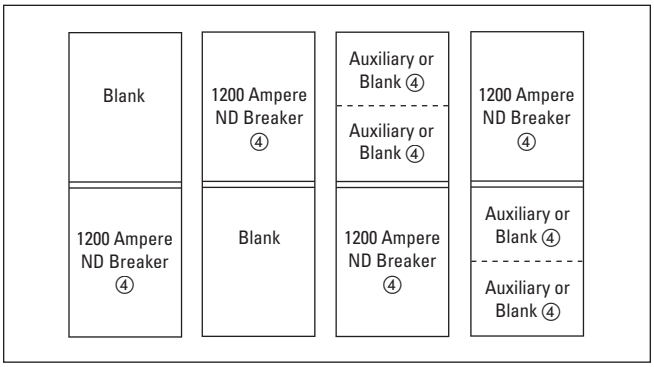


Figure 5.5-30. Available Configurations (Front View)

④ Relays or control devices cannot be mounted on the circuit breaker or auxiliary compartment door.

Typical Weights

Table 5.5-5. Switchgear Assembly (Less Breaker)

Vertical Section Type	Main Bus Rating, Amperes	Weight Lbs (kg)
B/A or A/B	1200 2000	1500 (682) 1700 (772)
A/A	1200 2000	1400 (636) 1600 (726)

Table 5.5-6. Circuit Breaker ⑤

Circuit Breaker Type	Current Rating, Amperes	Weight (Static) Lbs (kg)
50 VCPW-ND-250	1200	345 (157)

⑤ Breaker impact weight = 1.5 x static weight.

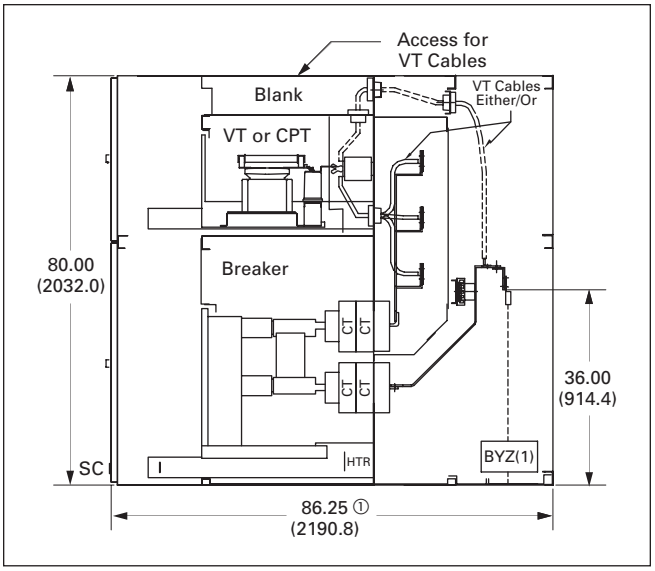


Figure 5.5-31. 36.00-Inch (660.4 mm) Wide VCP-W Low Profile Indoor Unit

① Other depths possible depending on cable entry direction and VT/CPT connections. Contact Eaton.

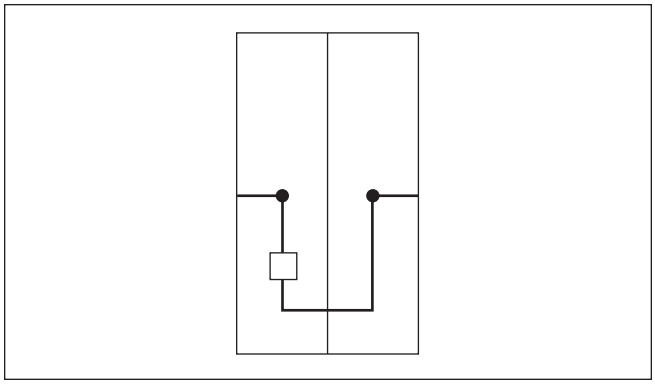


Figure 5.5-32. Tie Breaker Bus Transition Requirements

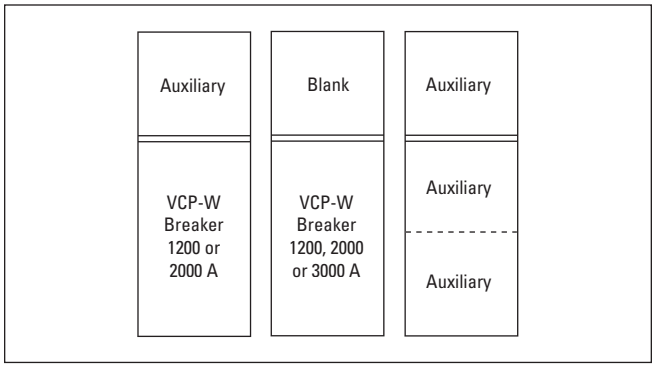


Figure 5.5-33. Available Configurations (Front View)

Typical Weights

Table 5.5-7. Assemblies (Less Breakers, See Table 5.5-2 for Breakers)

Vertical Section Type	Main Bus Rating, Amperes	Indoor Structure Lbs (kg)
B/B	1200 2000 3000	2200 (999) 2300 (1044) 2400 (1090)
B/A or A/B	1200 2000 3000	2100 (953) 2200 (999) 2300 (1044)
A/A	1200 2000 3000	1800 (818) 1900 (864) 2000 (908)

Layout Dimensions—27 kV One-High Design—Dimensions in Inches (mm)

Typical Units

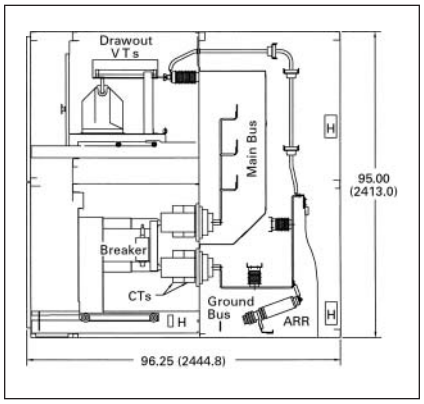


Figure 5.5-34. Indoor 36.00-Inch (914.4 mm) Wide Typical Auxiliary/Breaker Vertical Section

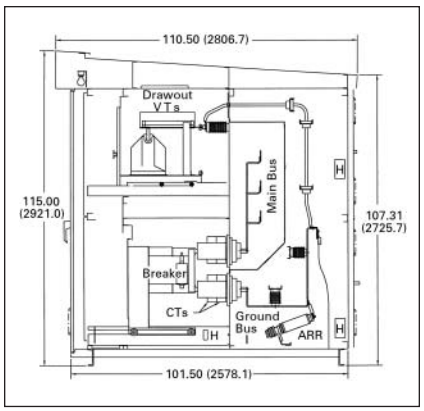


Figure 5.5-35. Outdoor Aisleless Typical Auxiliary/Breaker Vertical Section

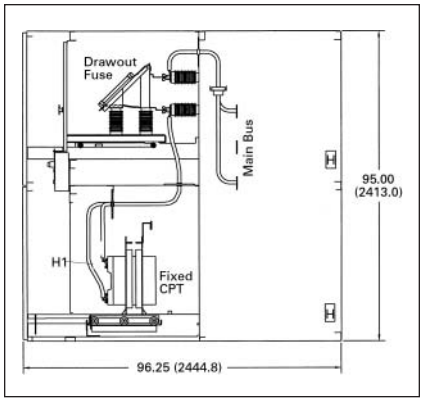


Figure 5.5-36. Indoor Auxiliaries 36.00-Inch (914.4 mm) Wide Typical Auxiliary/Auxiliary Vertical Section

Typical Weights in Lbs (kg)

Table 5.5-8. Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor	Outdoor Aisleless
A/B	1200 2000	2500 (1135) 2600 (1180)	3400 (1545) 3500 (1591)
A/A	1200 2000	2200 (999) 2300 (1045)	2800 (1271) 2900 (1317)

Table 5.5-9. Breaker Weights in Lbs (kg) ①

Type of Breaker	Current Rating, Amperes	
	1200	2000
270 VCP-W 750 270 VCP-W 1000	415 (188) 415 (188)	475 (216) 475 (216)
270 VCP-W 1250, 25C 270 VCP-W 40, 40C	415 (188) 415 (188)	475 (216) 475 (216)

① Breaker impact = 1.5 x breaker weight.

Available Configurations

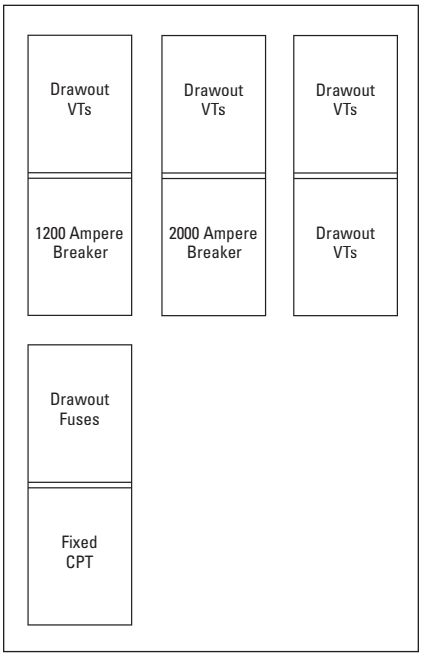


Figure 5.5-37. Available Configurations

5

Dimensions for estimating purposes only.

Dimensions in Inches (mm) (Continued)

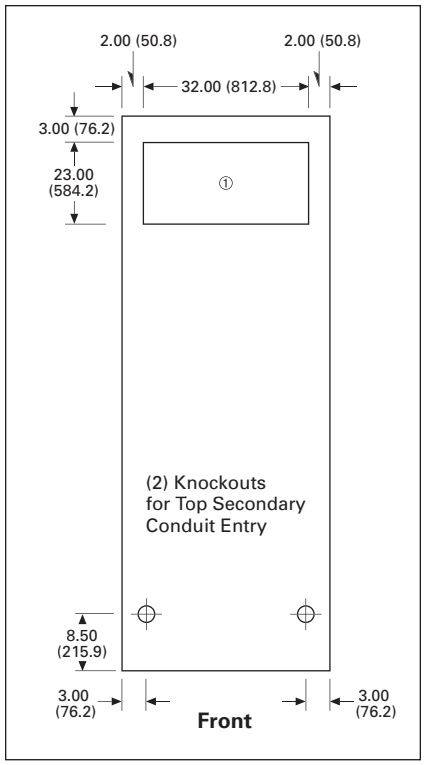


Figure 5.5-38. Top View of Typical Indoor Breaker and Auxiliary Structures

① Primary conduit locations for top or bottom entry.

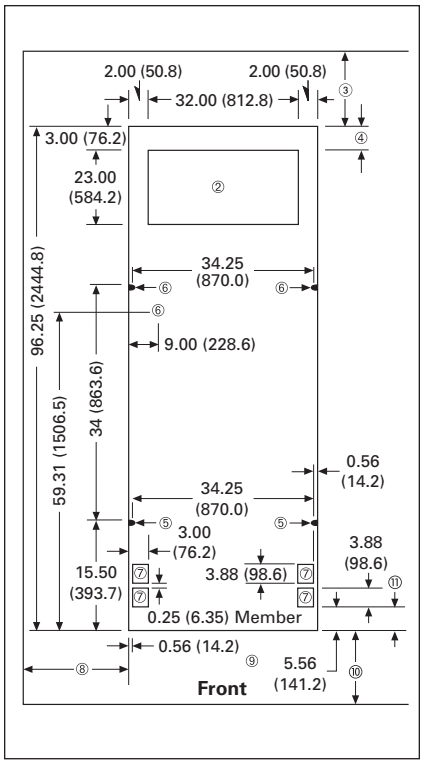


Figure 5.5-39. Base Plan of a Typical Indoor Breaker or Auxiliary Structure

② Primary conduit locations for top or bottom entry.
③ Recommended minimum clearance to rear of VacClad-W: 36.00 inches (914.4 mm).
④ Floor steel, if used, must not exceed 3.25 inches (82.6 mm) under VacClad-W.
⑤ Anchor locations: indoor—0.50-inch (12.7 mm) bolts or weld, outdoor—0.50-inch (12.7 mm) bolts.
⑥ Station ground connection provision.
⑦ Secondary conduit space: All—maximum of 1.00-inch (25.4 mm) projection.
⑧ Minimum clearance to LH side of VacClad-W: 32.00 inches (812.8 mm).
⑨ Finished foundation surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back, and diagonally, as measured by a laser level.
⑩ Minimum clearance to front of VacClad-W: 72.00 inches (1828.8 mm).
⑪ Floor steel if used, must not exceed this dimension under VacClad-W.

Note: Outdoor Aisleless Base Plan—27 kV switchgear outdoor Aisleless base plan details are same as 5/15 kV outdoor Aisleless switchgear. Refer to **Figure 5.5-14**.

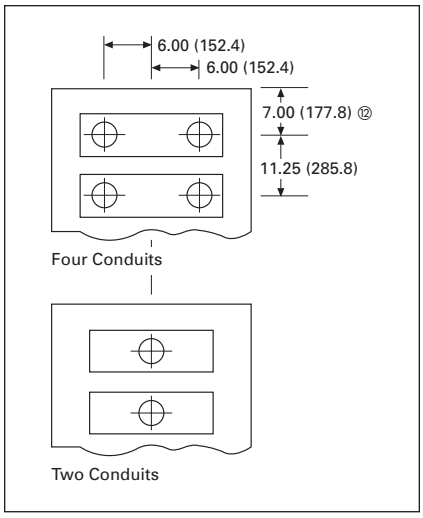


Figure 5.5-40. Primary Conduit Locations for Top or Bottom Entry

⑫ Changes to 8.25 inches (209.6 mm) if optional hinged rear doors are required.

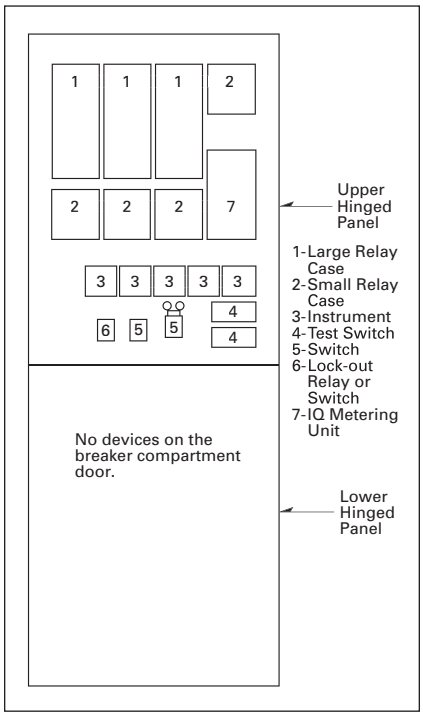


Figure 5.5-41. Maximum Hinged Panel Equipment

Note: The figure above shows that the arrangement of components differs between upper and lower panels. The figure may also be used to select custom arrangements of hinged panel components. Also, the use of multi-purpose solid-state relays such as Eaton's Digitrip 3000 (same size as device 7) will significantly reduce consumption of panel space.

Dimensions for estimating purposes only.

Layout Dimensions—27 kV Two-High Design—Dimensions in Inches (mm)

Typical Units—Indoor ①

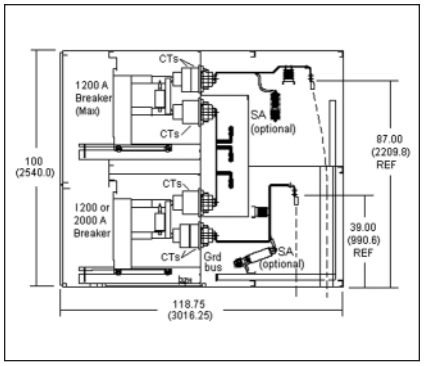


Figure 5.5-42. Indoor 36.00-Inch (914.4 mm) Wide Typical Breaker-over-Breaker Vertical Section

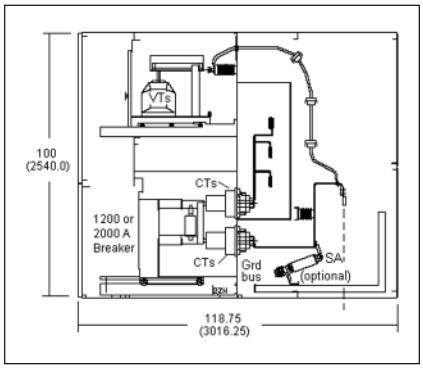


Figure 5.5-43. 36.00-Inch (914.4 mm) Wide Typical Auxiliary-over-Breaker Vertical Section

① For 1-high arrangement (1 breaker per cell), depth may be reduced to 108.64 inches (2759.5 mm).

Available Configurations ②

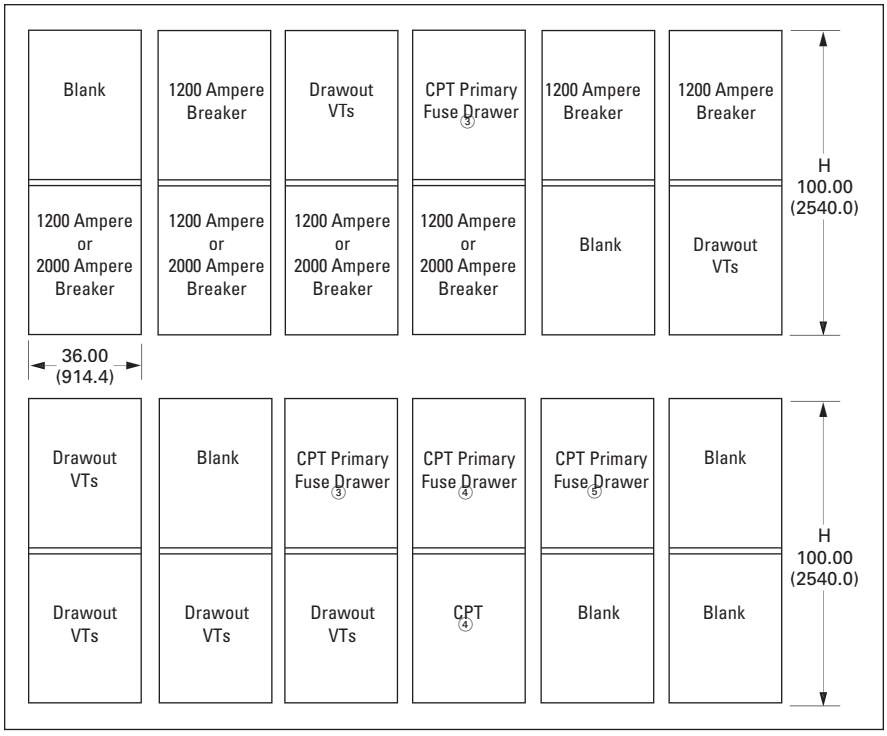


Figure 5.5-44. Available Configurations

② Available Main Bus Ratings for 27 kV two-high design are 1200A, 2000A, 2500A or 2700A.
③ Bus connected, maximum 4A fuses. CPT is installed remote from the switchgear.
④ Fuses are bus or line connected. CPT is installed in front bottom, on drawout frame. Maximum CPT size is single-phase 37.5 kVA or three-phase 45 kVA.
⑤ Bus or Line connected, maximum 4A fuses. CPT is installed remote from the switchgear.

Tie Breaker Bus Transition Requirements

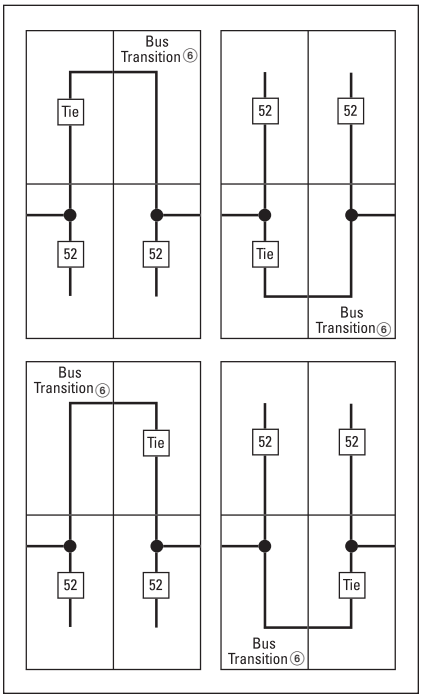


Figure 5.5-45. Tie Breaker Bus Transition Requirements

⑥ Breakers cannot be located in bus transition compartment.

Typical Weights

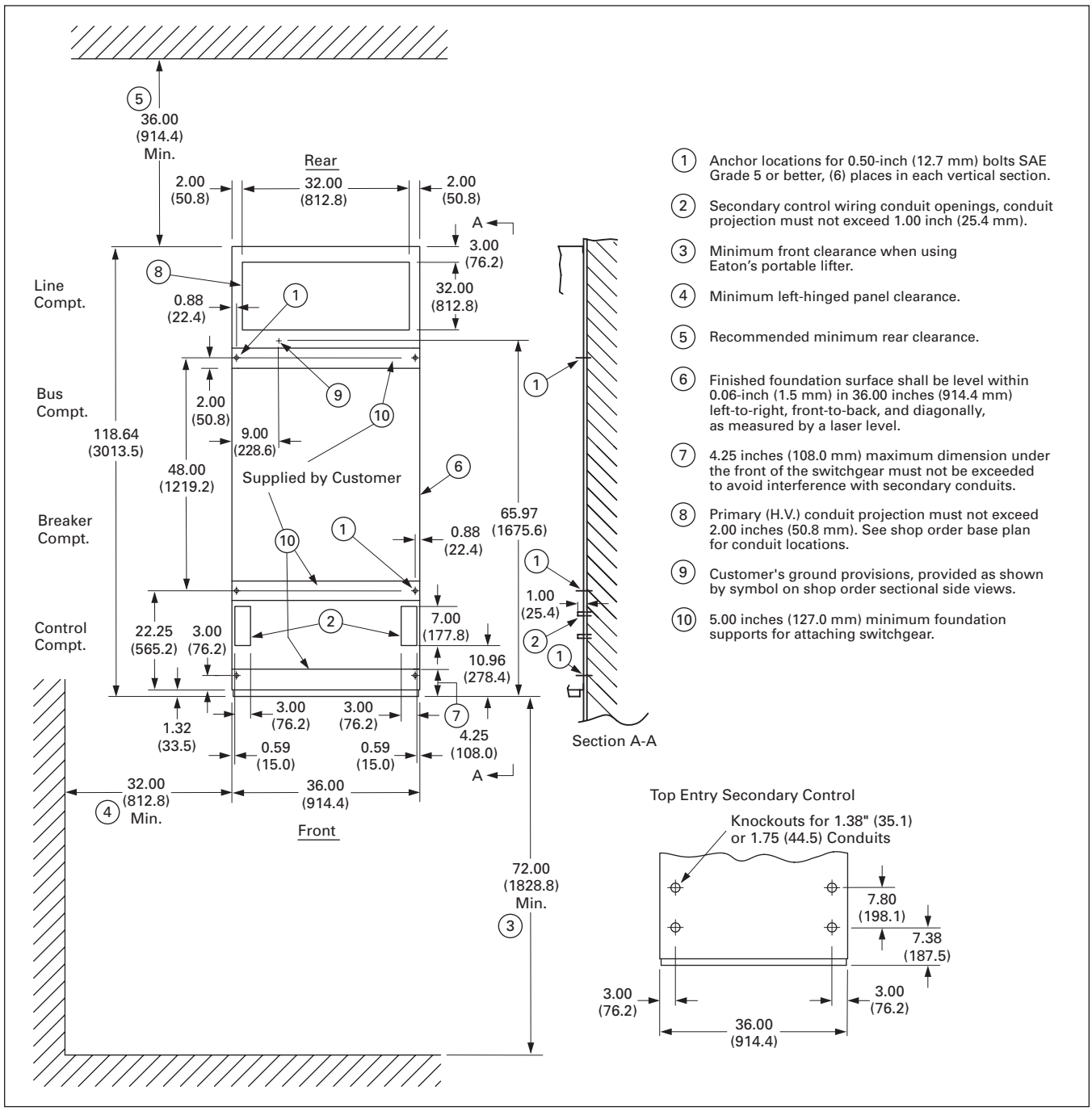
Table 5.5-10. Assemblies (Less Breakers) ⑦

Type of Vertical Section	Main Bus Rating, Amperes	Weight Lbs (kg)
Aux/Bkr	1200 2000 2500 2700	2500 (1135) 2600 (1180) 2600 (1180) 2700 (1227)
Aux/Aux	1200 2000 2500 2700	2200 (1000) 2300 (1046) 2300 (1046) 2400 (1091)
Bkr/Bkr	1200 2000 2500 2700	2700 (1227) 2800 (1273) 2800 (1273) 2900 (1318)

⑦ Refer to **Table 5.5-9** for breaker weights.

Dimensions for estimating purposes only.

Typical Floor Plan—27 kV Two-High, Indoor



1. Anchor locations for 0.50-inch (12.7 mm) bolts SAE Grade 5 or better, (6) places in each vertical section.
2. Secondary control wiring conduit openings, conduit projection must not exceed 1.00 inch (25.4 mm).
3. Minimum front clearance when using Eaton's portable lifter.
4. Minimum left-hinged panel clearance.
5. Recommended minimum rear clearance.
6. Finished foundation surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back, and diagonally, as measured by a laser level.
7. 4.25 inches (108.0 mm) maximum dimension under the front of the switchgear must not be exceeded to avoid interference with secondary conduits.
8. Primary (H.V.) conduit projection must not exceed 2.00 inches (50.8 mm). See shop order base plan for conduit locations.
9. Customer's ground provisions, provided as shown by symbol on shop order sectional side views.
10. 5.00 inches (127.0 mm) minimum foundation supports for attaching switchgear.

Figure 5.5-46. Typical Floor Plan—27 kV Two-High, Indoor

Dimensions for estimating purposes only.

Layout Dimensions—38 kV, 170 kV BIL Design—Dimensions in Inches (mm)

Typical Units

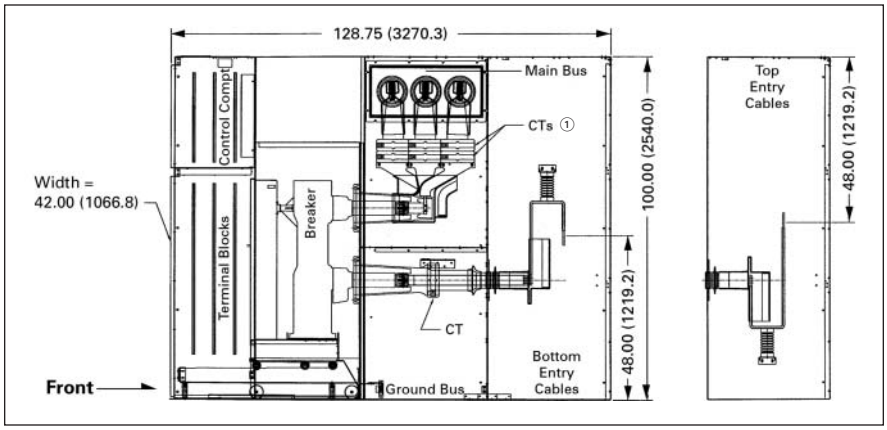


Figure 5.5-47. Indoor—Typical Breaker, Vertical Section, Bottom Cable Exit

① Bus side CT bushings are not provided if there are no bus side CTs.

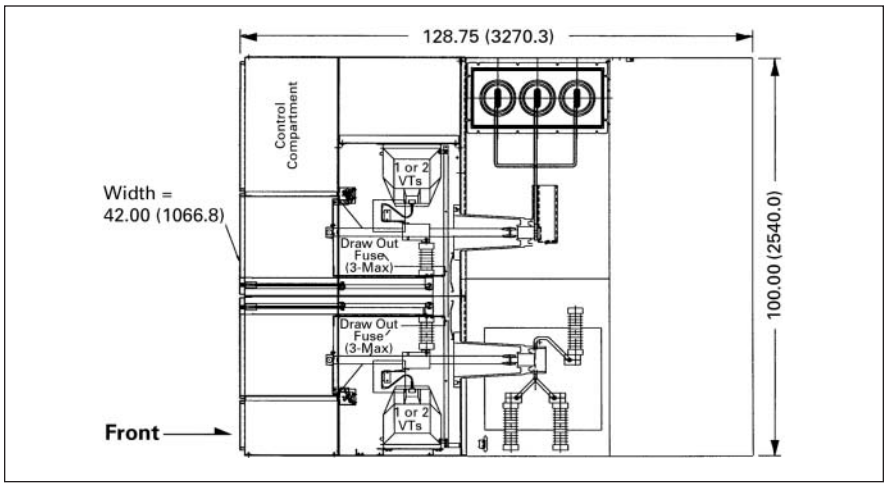


Figure 5.5-48. Indoor—Typical Auxiliary/Auxiliary

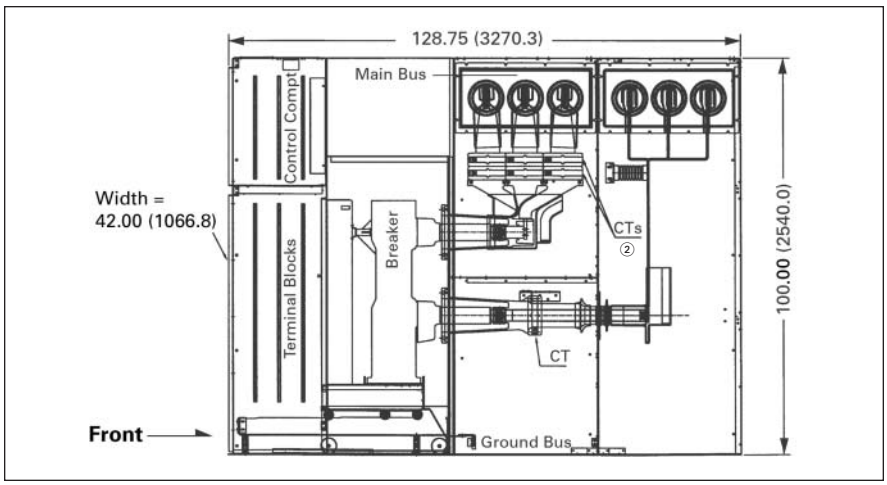


Figure 5.5-49. Indoor—Typical Bus Tie Breaker, Vertical Section

② Bus side CT bushings are not provided if there are no bus side CTs.

Typical Weights in Lbs (kg)

Table 5.5-11. Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor
Breaker	1200 2000 2500 3000	3300 (1500) 3400 (1545) 3555 (1616) 3555 (1616)
Auxiliary	1200 2000 2500 3000	3200 (1453) 3300 (1500) 3455 (1570) 3455 (1570)

Table 5.5-12. Breaker Weights in Lbs (kg)

Type of Breaker	Current Rating, Amperes	
	1200	2000
380 VCP-W-16, 16C 380 VCP-W-25, 25C	1080 (490) 1080 (490)	1140 (518) 1140 (518)
380 VCP-W-32, 32C 380 VCP-W-21	1080 (490) 1080 (490)	1140 (518) 1140 (518)
380 VCP-W-40, 40C	1080 (490) 1080 (490)	1140 (518) 1140 (518)

5

Dimensions for estimating purposes only.

Dimensions in Inches (mm) (Continued)

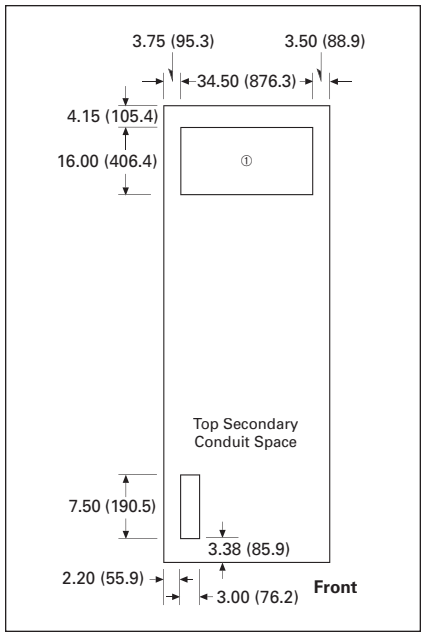


Figure 5.5-50. Top View of Typical Indoor Breaker and Auxiliary Structures

① Primary conduit locations for top or bottom entry.

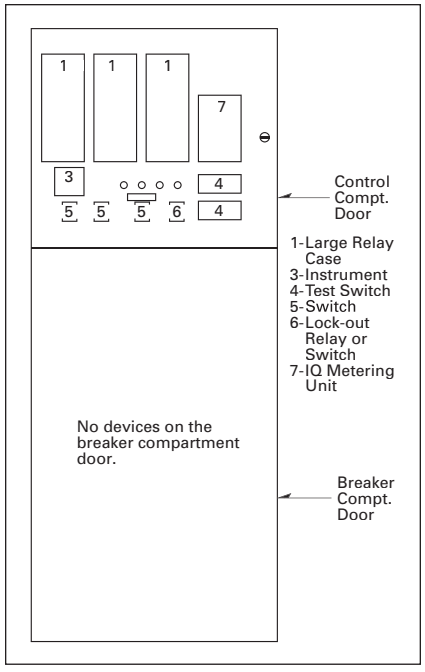


Figure 5.5-51. Maximum Hinged Panel Equipment

Note: The figure above shows that the arrangement of components. The figure may also be used to select custom arrangements of hinged panel components. Also, the use of multi-purpose solid-state relays such as Eaton's Digitrip 3000 (same size as device 7) will significantly reduce consumption of panel space.

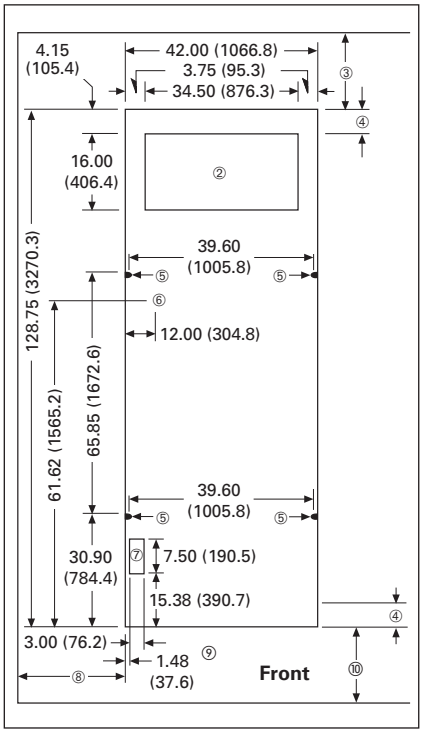


Figure 5.5-52. Base Plan of a Typical Indoor Breaker and Auxiliary Structure

② Primary conduit locations for top or bottom entry.
③ Recommended minimum clearance to rear of VacClad-W: 42.00 inches (1066.8 mm).
④ Floor steel, if used, must not exceed 3.25 inches (82.6 mm) under VacClad-W.
⑤ Anchor locations: indoor—0.50-inch (12.7 mm) bolts or weld, outdoor—0.50-inch (12.7 mm) bolts.
⑥ Station ground connection provision.
⑦ Secondary conduit space: All—maximum of 1.00-inch (25.4 mm) projection.
⑧ Minimum clearance to LH side of VacClad-W: 38.00 inches (965.2 mm).
⑨ Finished foundation surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back, and diagonally, as measured by a laser level.
⑩ Minimum clearance to front of VacClad-W: 84.00 inches (2133.6 mm).

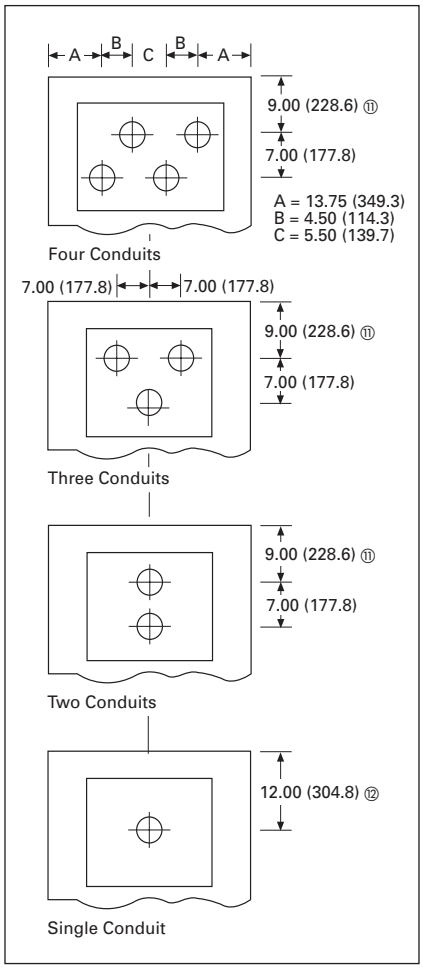


Figure 5.5-53. Primary Conduit Locations for Top or Bottom Entry

⑪ Changes to 10.25 inches (260.4 mm) if optional hinged rear doors are required.
⑫ Changes to 13.25 inches (336.6 mm) if optional hinged rear doors are required.

Layout Dimensions—38 kV, 150 kV BIL Design—Dimensions in Inches (mm)

Typical Units

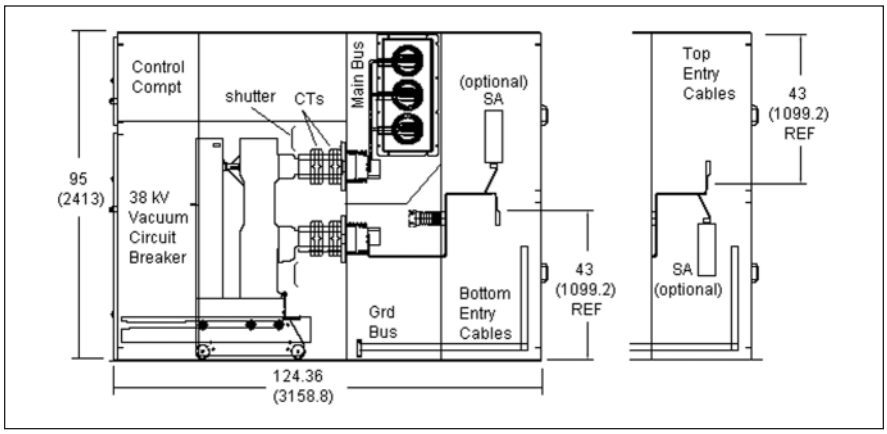


Figure 5.5-54. Indoor—Typical Breaker, Main or Feeder

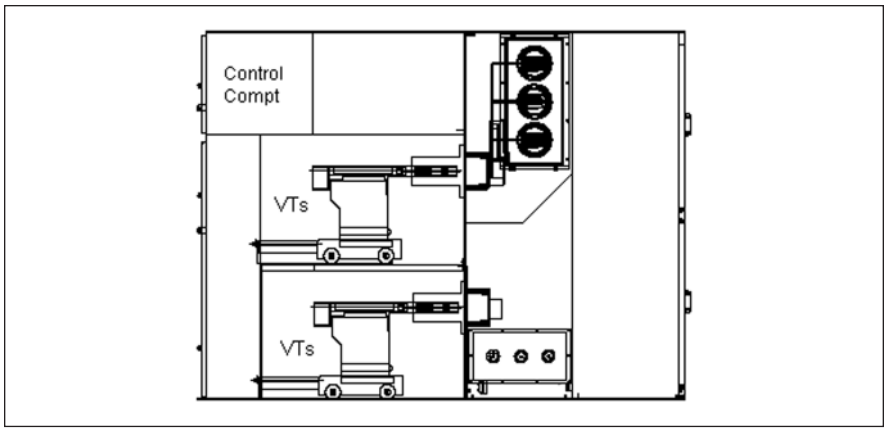


Figure 5.5-55. Typical Auxiliary-over-Auxiliary

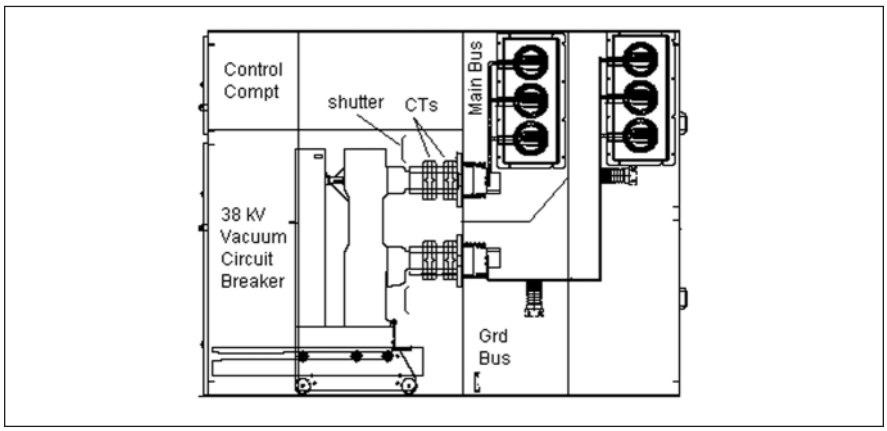


Figure 5.5-56. Typical Bus Tie Breaker

Typical Weights in Lbs (kg) ①

Table 5.5-13. Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor
Breaker	1200 2000 2500	3100 (1409) 3200 (1455) 3355 (1525)
Auxiliary	1200 2000 2500	3000 (1364) 3100 (1409) 3355 (1525)

① Refer to **Table 5.5-12** for breaker weights.

5

Dimensions for estimating purposes only.

Layout Dimensions—38 kV, 150 kV BIL Design—Dimensions in Inches (mm)

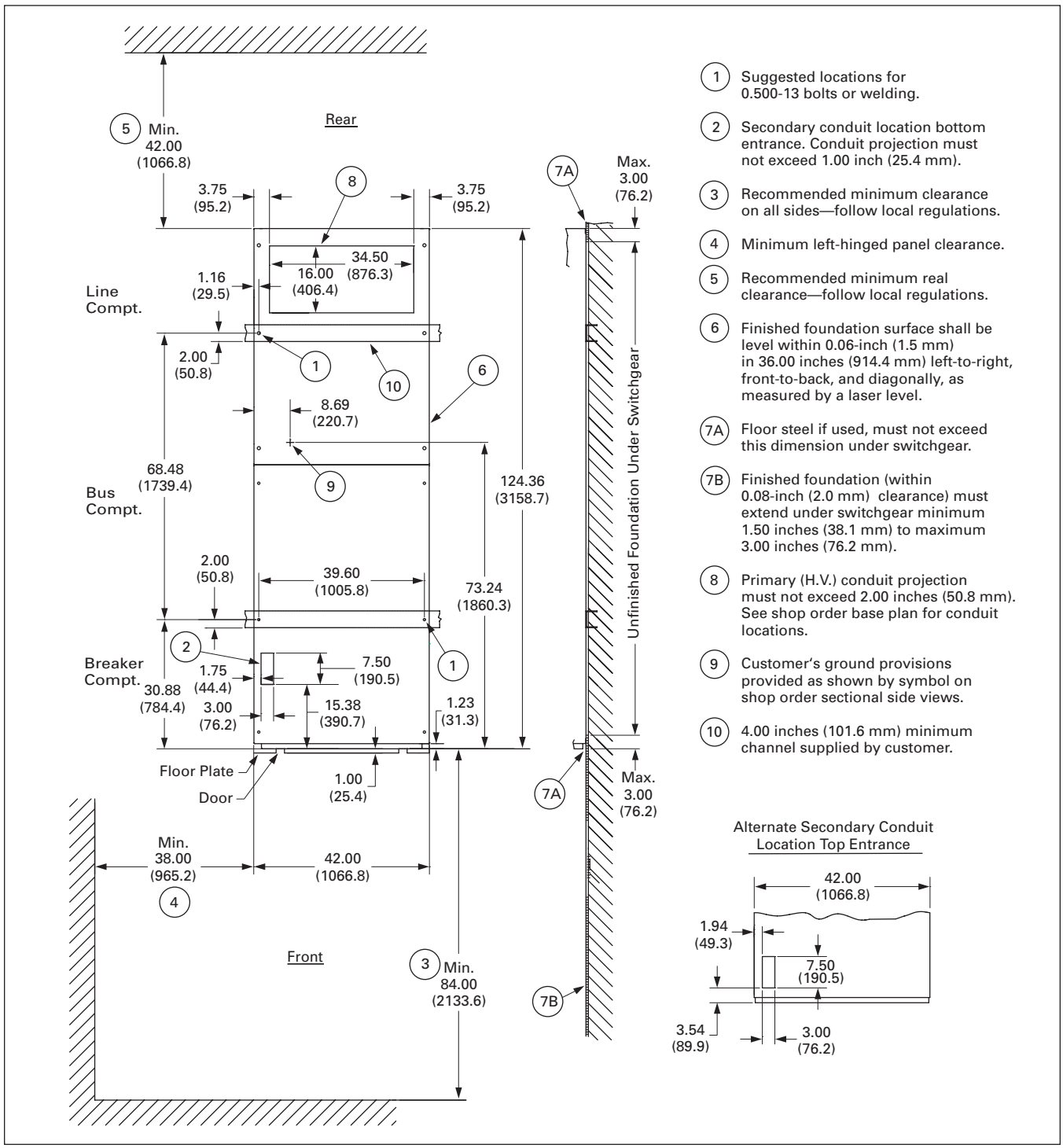


Figure 5.5-57. Indoor—Typical Indoor Base Plan

Typical Application Layouts

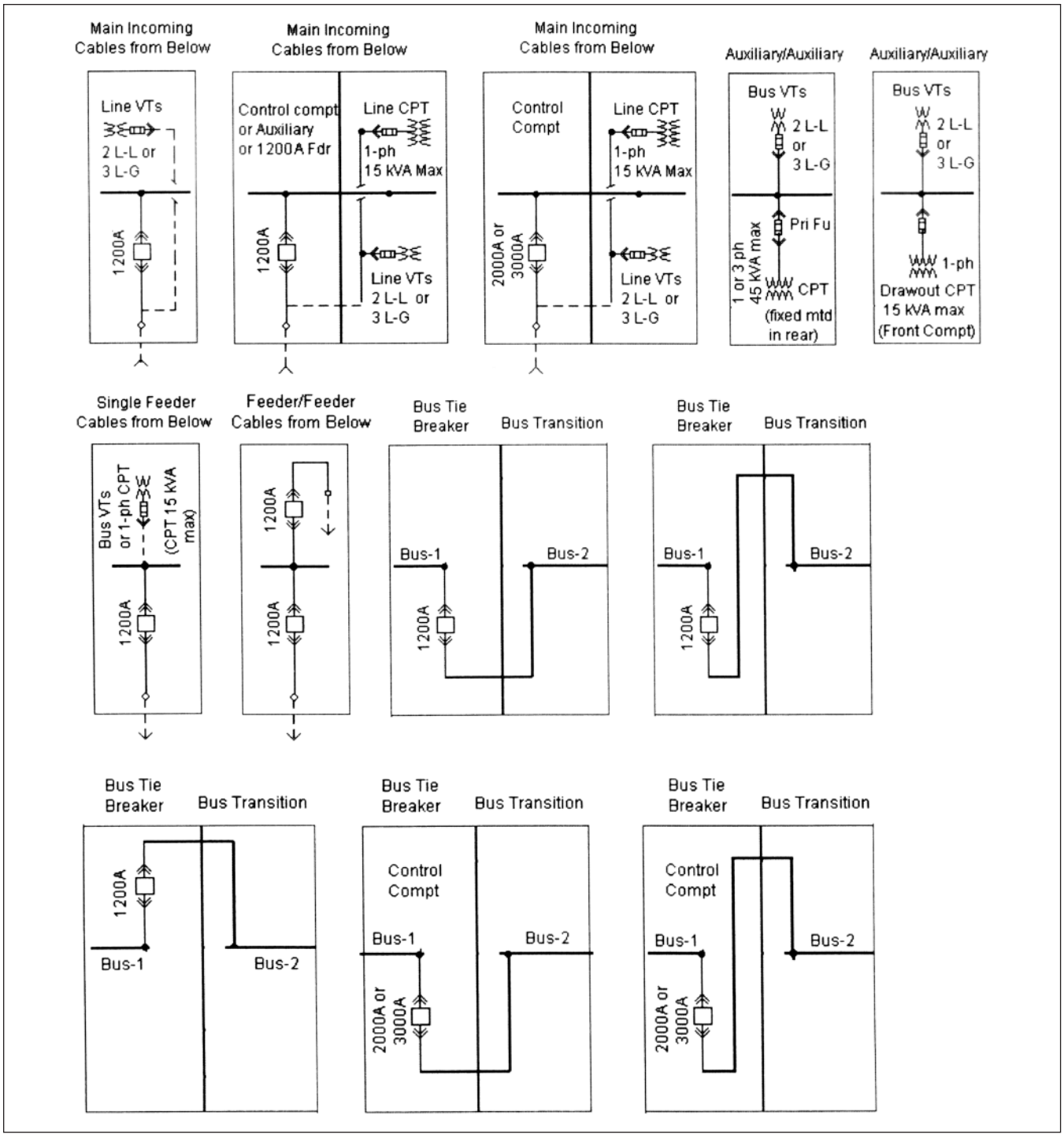


Figure 5.5-58. Typical Arc-Resistant Switchgear Application Layouts—5 and 15 kV

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 5.5-61** to **5.5-66** for dimensions.

Typical Application Layouts

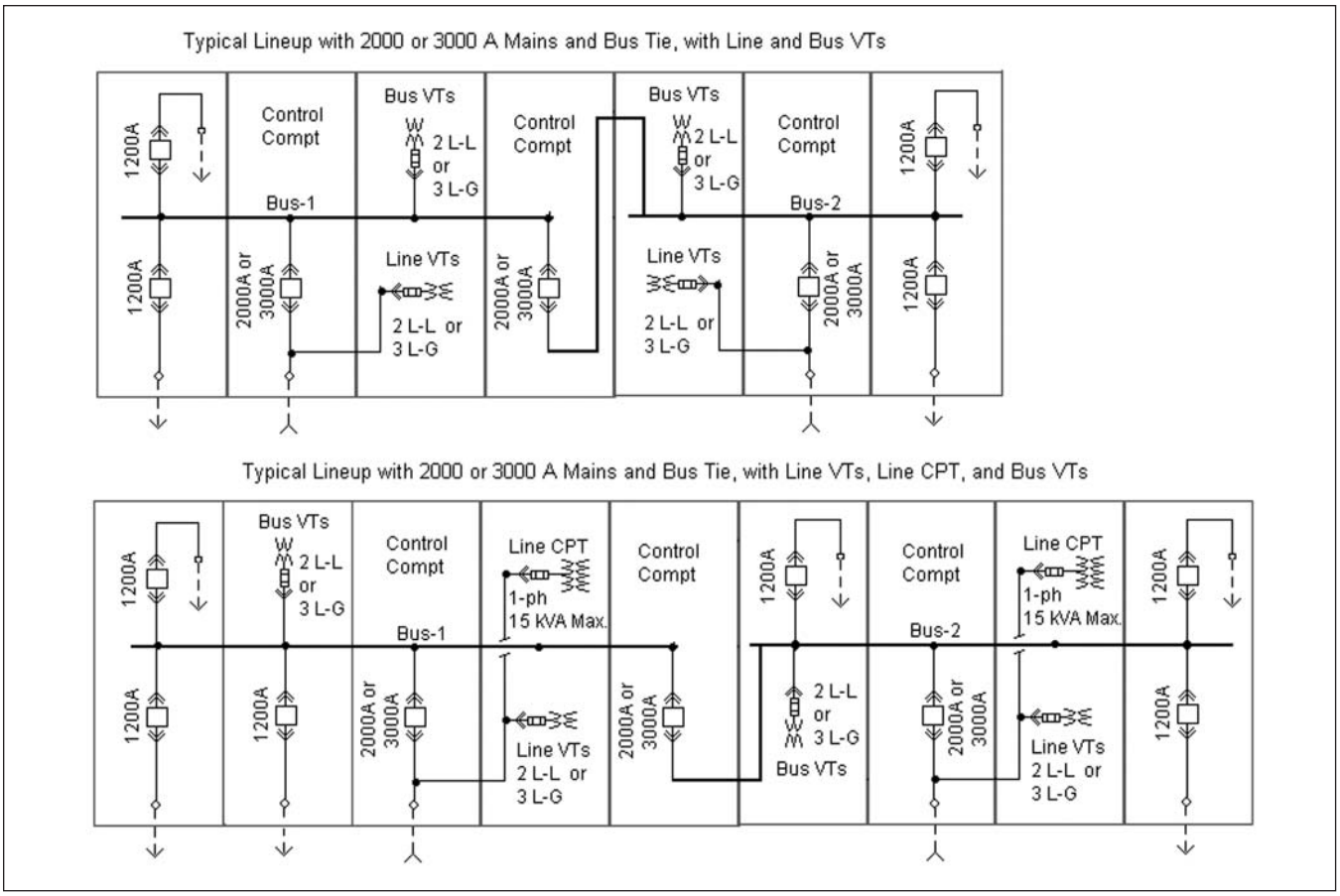


Figure 5.5-59. Typical Arc-Resistant Switchgear Application Layouts—5 and 15 kV

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 5.5-61** to **5.5-66** for dimensions.

Typical Application Layouts (Continued)

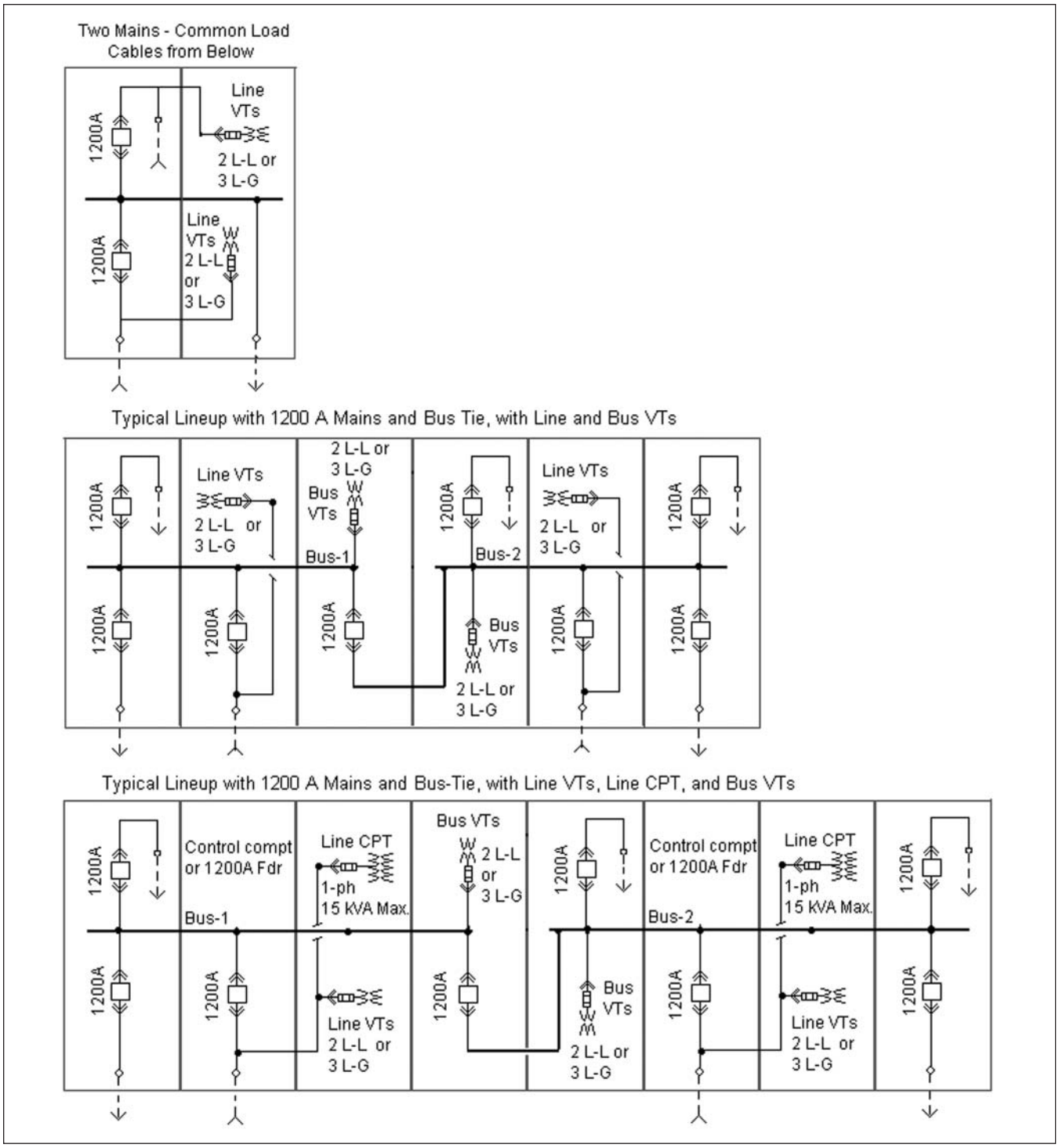
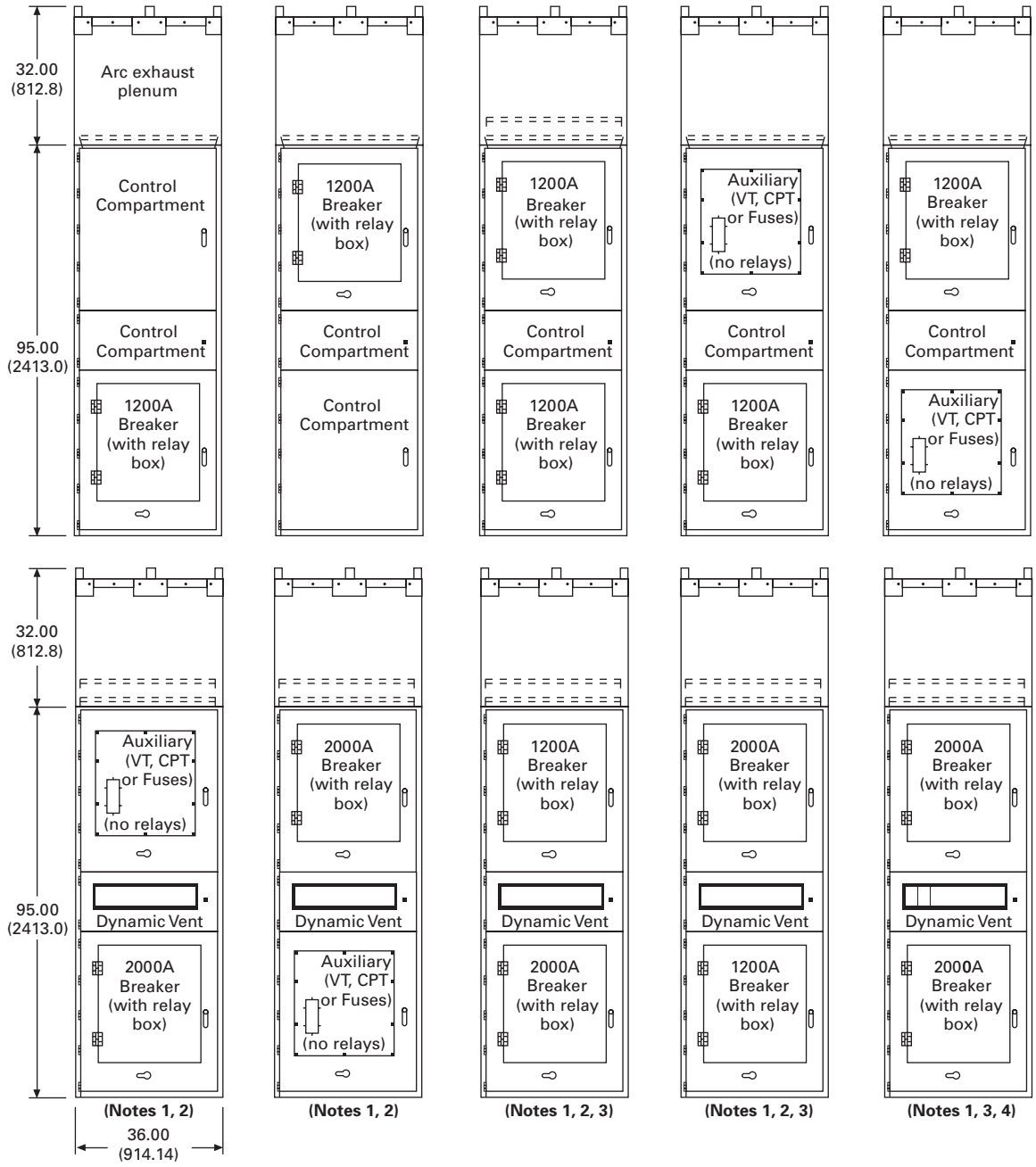


Figure 5.5-60. Typical Arc-Resistant Switchgear Application Layouts—5 and 15 kV

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 5.5-61** to **5.5-66** for dimensions.

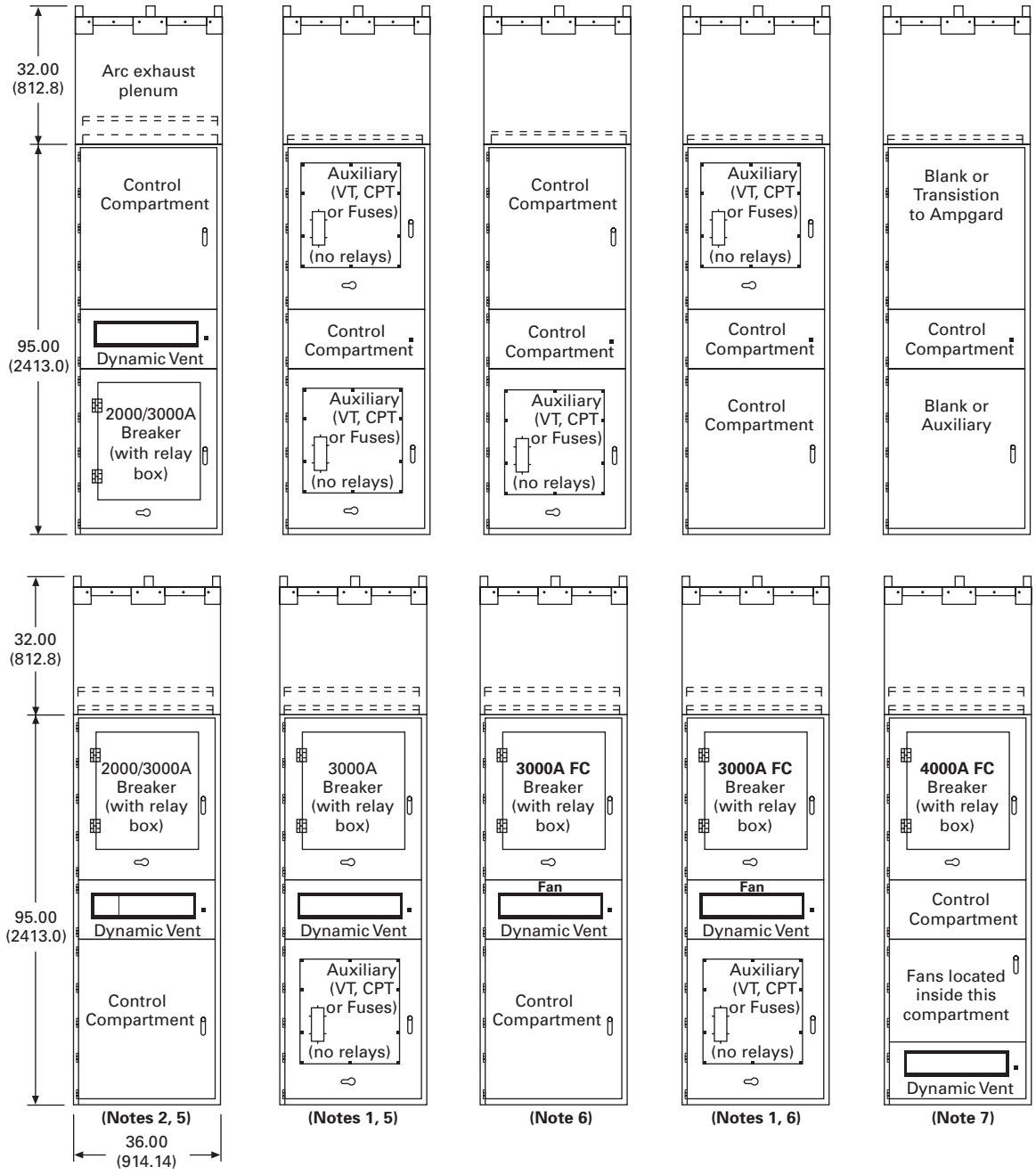
Available Configurations



Notes:
1 = Please note that the only control space available for relays and LV devices for this configuration is the relay box located on the breaker compartment door.
2 = Maximum current through a 2000A breaker in this location must be limited to 1750A.
3 = This configuration requires use of a 4000A main bus.
4 = Maximum current through each 2000A breaker in this configuration must be limited to 1750A each.

Figure 5.5-61. Available Arc-Resistant Switchgear Configurations (Front Views)—5 and 15 kV

Available Configurations



Notes:
1 = Please note that the only control space available for relays and LV devices for this configuration is the relay box located on the breaker compartment door.
2 = Maximum current through a 2000A breaker in this location must be limited to 1750A.
5 = Maximum current through a 3000A breaker in this location must be limited to 2500A.
6 = Maximum current allowed through a 3000A circuit breaker in this configuration is 3000A with fans running, and 2500A when fans are not running.
7 = Maximum current allowed through a 3000A circuit breaker in this configuration is 4000A with fans running, and 2500A when fans are not running.

Figure 5.5-61. Available Arc-Resistant Switchgear Configurations (Front Views)—5 and 15 kV (Continued)

Typical Sectional Side Views

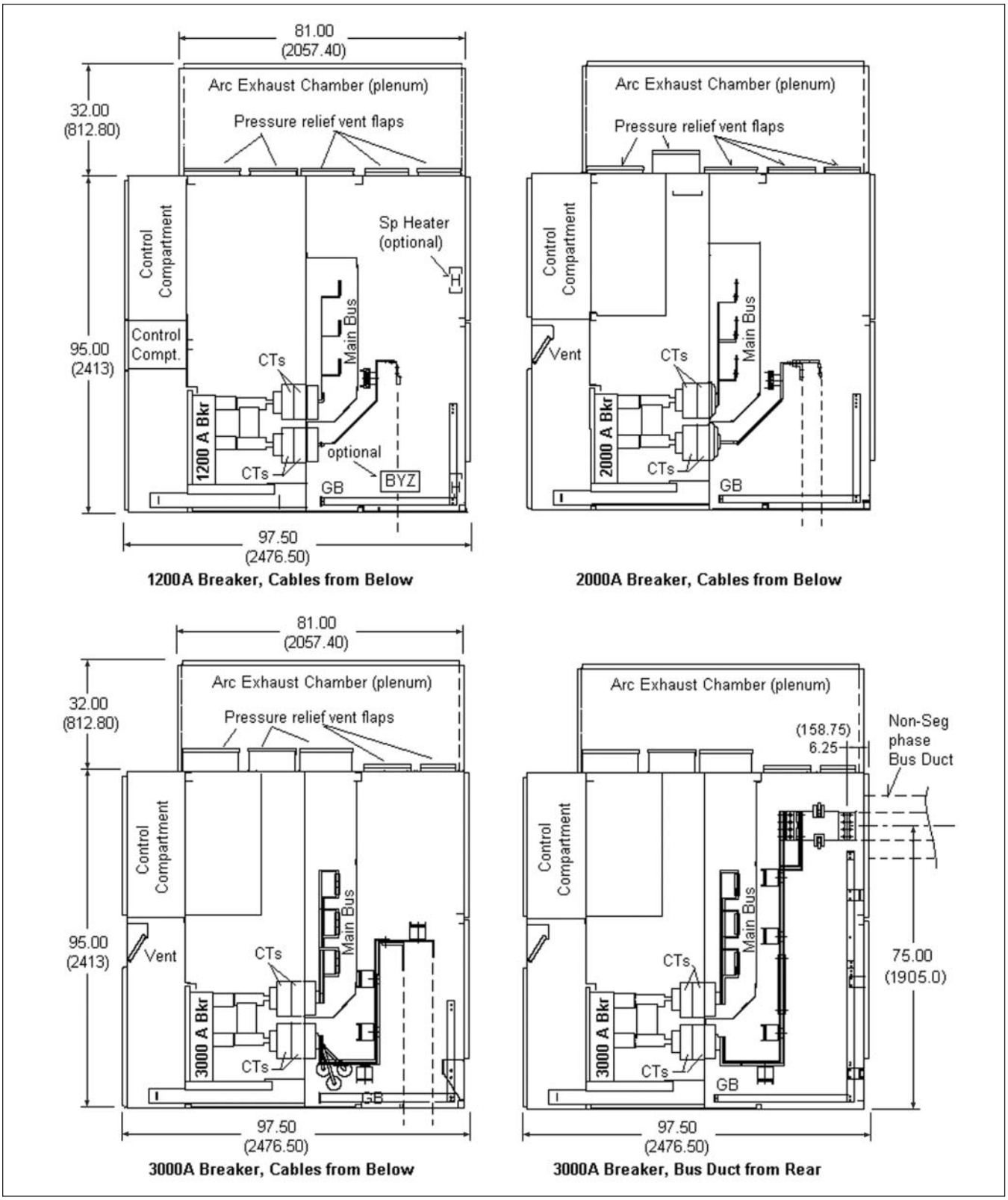


Figure 5.5-62. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

Typical Sectional Side Views (Continued)

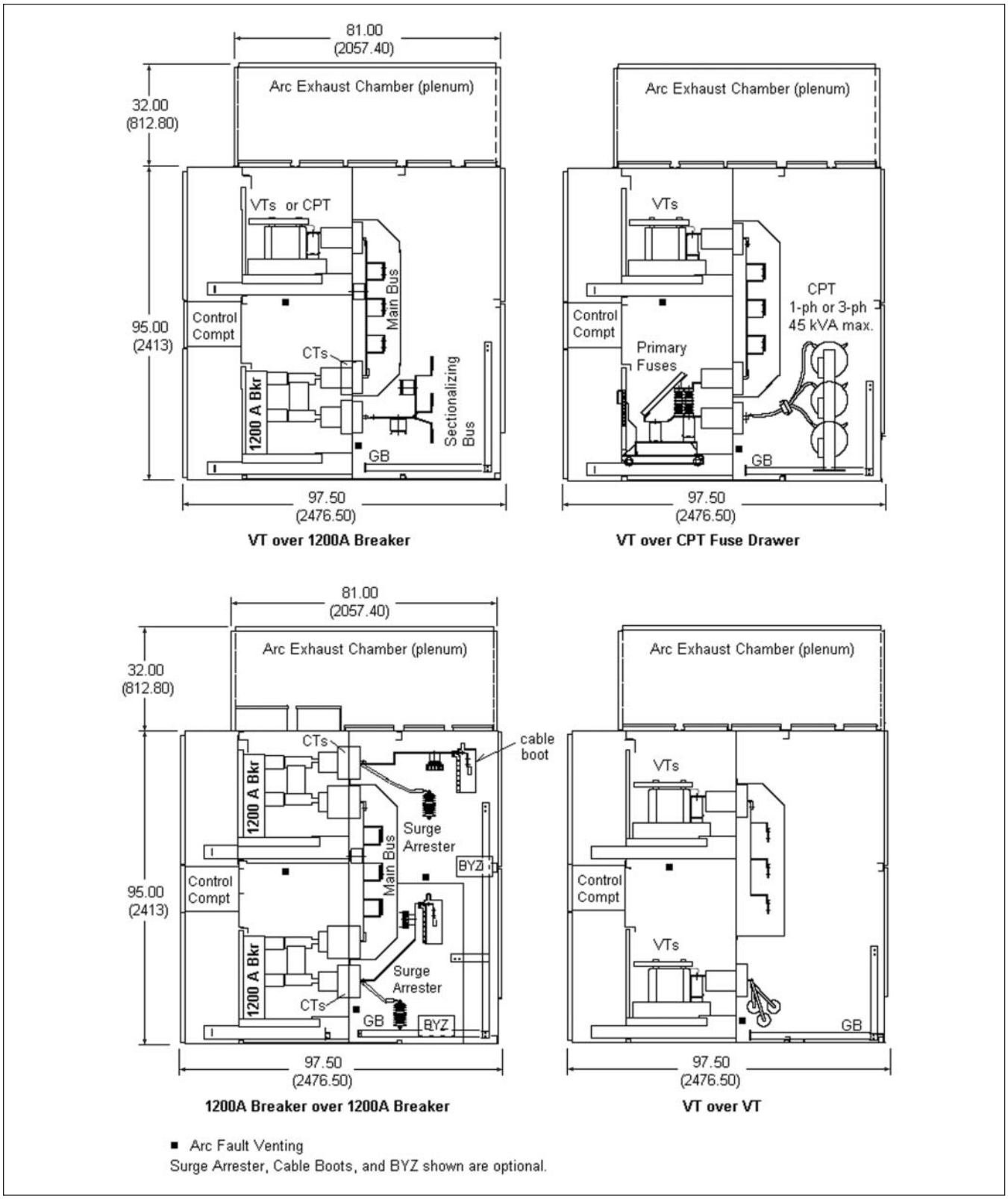
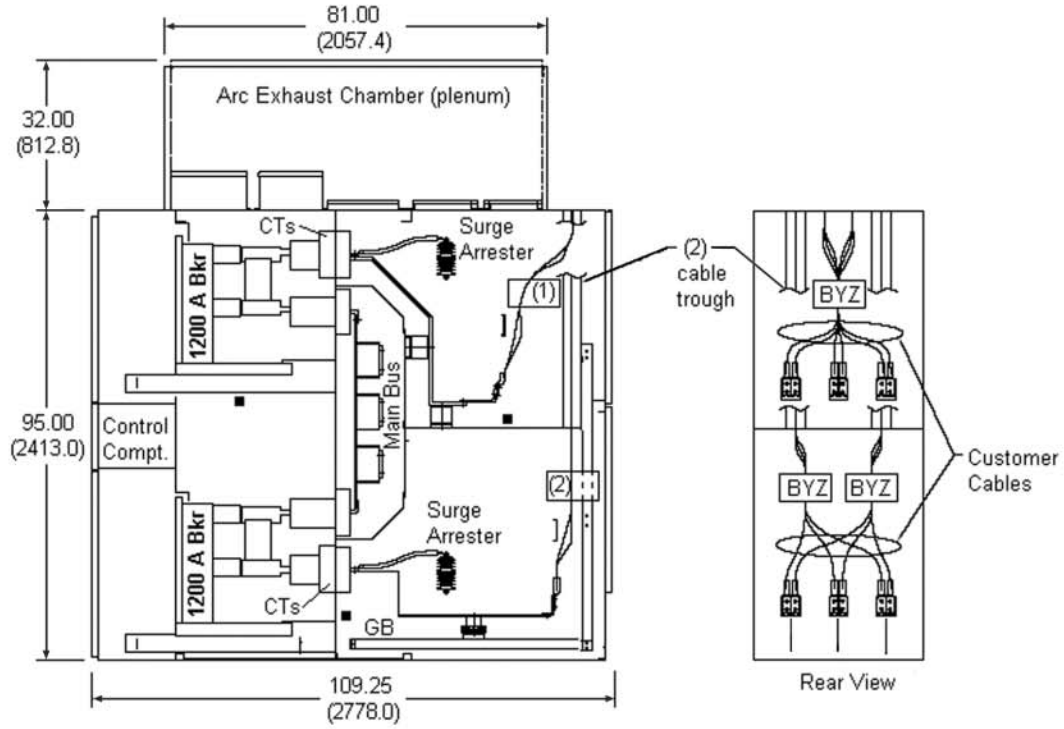


Figure 5.5-63. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

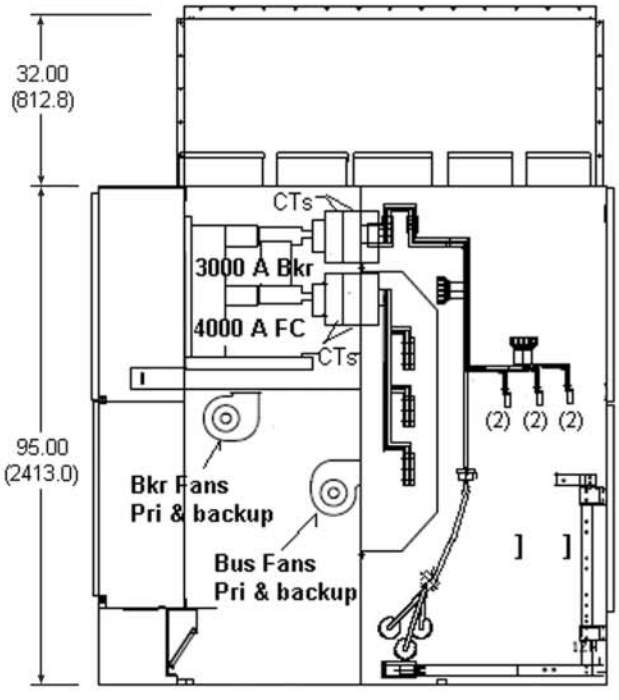
Typical Sectional Side Views (Continued)



1200A Bkr over 1200A Bkr, Cables from Top

- Arc Fault Venting

Surge Arrester, Cable Boots, and BYZ shown are optional.



4000A Fan Cooled

Figure 5.5-64. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

5/15 kV Arc-Resistant Switchgear—Typical Weights

Table 5.5-14. Assemblies (Less Breakers) ①②③④

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	Lbs (kg)	Lbs (kg)	Lbs (kg)
Breaker/breaker	1200 2000 3000 4000	2800 (1271) 2900 (1317) 3000 (1362) 3100 (1407)	3025 (1374) 3175 (1441) 3275 (1487) 3375 (1532)	3175 (1441) 3375 (1532) 3475 (1578) 3575 (1623)
Blank/breaker or breaker/blank	1200 2000 3000 4000	2700 (1226) 2800 (1271) 2900 (1317) 3000 (1362)	2900 (1317) 3125 (1419) 3150 (1430) 3275 (1487)	3125 (1419) 3175 (1441) 3325 (1510) 3475 (1578)
Auxiliary/breaker or breaker/auxiliary	1200 2000 3000 4000	2650 (1203) 2750 (1248) 2850 (1294) 2950 (1339)	2850 (1294) 2975 (1351) 3100 (1407) 3225 (1464)	2975 (1351) 3225 (1464) 3275 (1487) 3450 (1566)
Auxiliary/auxiliary	1200 2000 3000 4000	2600 (1180) 2700 (1226) 2800 (1271) 2900 (1317)	2800 (1271) 2925 (1328) 3050 (1385) 3175 (1441)	2925 (1328) 3175 (1441) 3225 (1464) 3375 (1532)
Blank/auxiliary or auxiliary/blank	1200 2000 3000 4000	2500 (1135) 2600 (1180) 2700 (1226) 2800 (1271)	2700 (1226) 2825 (1283) 2950 (1339) 3075 (1396)	2825 (1283) 2975 (1351) 3125 (1419) 3275 (1487)
Blank/blank	1200 2000 3000 4000	2500 (1135) 2600 (1180) 2700 (1226) 2800 (1271)	2700 (1226) 2825 (1283) 2950 (1339) 3075 (1396)	2825 (1283) 2975 (1351) 3125 (1419) 3275 (1487)

① Refer to **Table 5.5-2** for breaker weights.
② Add weights of end-wall to left and right end structures as follows:
350 Lbs (159.1 kg) for 97.50-inch (2476.5) D structures.
390 Lbs (177.3 kg) for 109.50-inch (2781.3) D structures.
430 Lbs (195.4 kg) for 121.50-inch (3086.1) D structures.
③ Add plenum weight as follows:
300 Lbs (136.4 kg) to left and right end structures.
200 Lbs (91.0 kg) to each intermediate structures.
④ Add arc duct assembly weight as follows:
200.00 Lbs (91.0 kg) for standard 51.00-inch (1295.4 mm) arc exhaust duct assembly.
30.00 Lbs (14.0 kg) per foot for additional arc duct.

Typical Top Plan

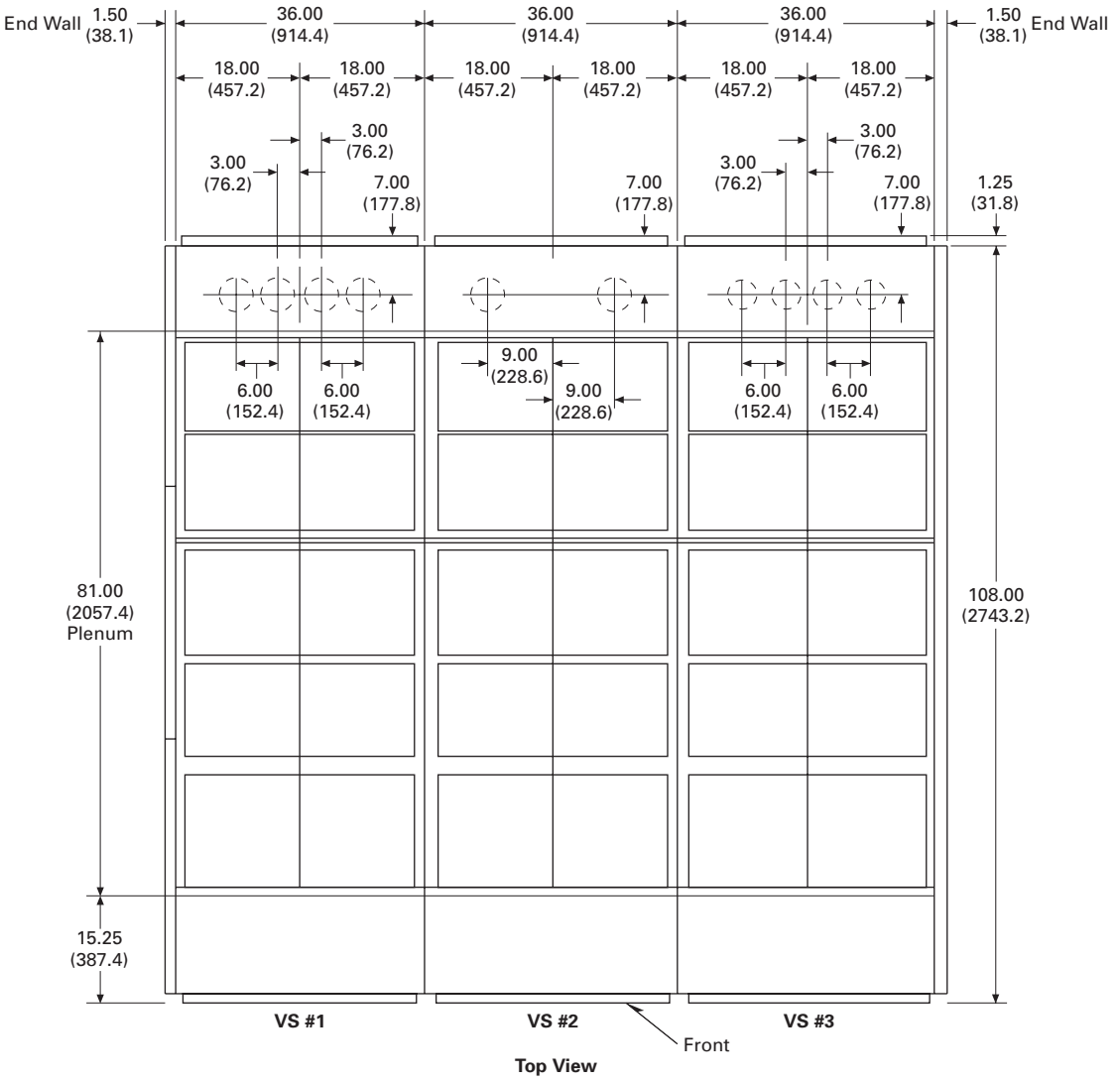
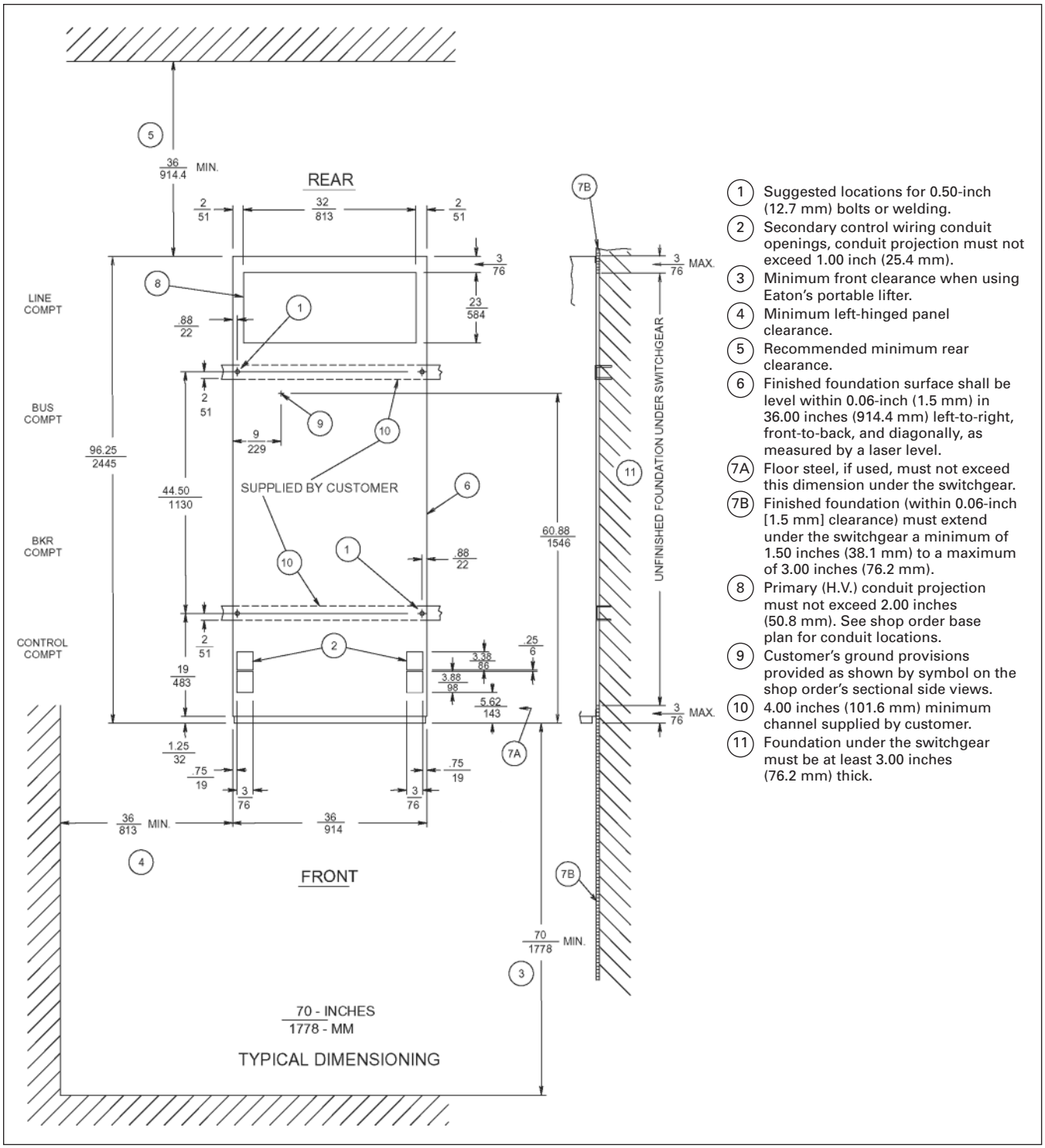


Figure 5.5-65. Typical Arc-Resistant Switchgear, Top Entry Cables—Typical Conduit Entrance Locations—5 and 15 kV

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.

Typical Floor Plan



1. Suggested locations for 0.50-inch (12.7 mm) bolts or welding.
2. Secondary control wiring conduit openings, conduit projection must not exceed 1.00 inch (25.4 mm).
3. Minimum front clearance when using Eaton's portable lifter.
4. Minimum left-hinged panel clearance.
5. Recommended minimum rear clearance.
6. Finished foundation surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back, and diagonally, as measured by a laser level.
7A. Floor steel, if used, must not exceed this dimension under the switchgear.
7B. Finished foundation (within 0.06-inch [1.5 mm] clearance) must extend under the switchgear a minimum of 1.50 inches (38.1 mm) to a maximum of 3.00 inches (76.2 mm).
8. Primary (H.V.) conduit projection must not exceed 2.00 inches (50.8 mm). See shop order base plan for conduit locations.
9. Customer's ground provisions provided as shown by symbol on the shop order's sectional side views.
10. 4.00 inches (101.6 mm) minimum channel supplied by customer.
11. Foundation under the switchgear must be at least 3.00 inches (76.2 mm) thick.

Figure 5.5-66. Typical Arc-Resistant Switchgear Floor Plan—5 and 15 kV

Typical Application Layouts

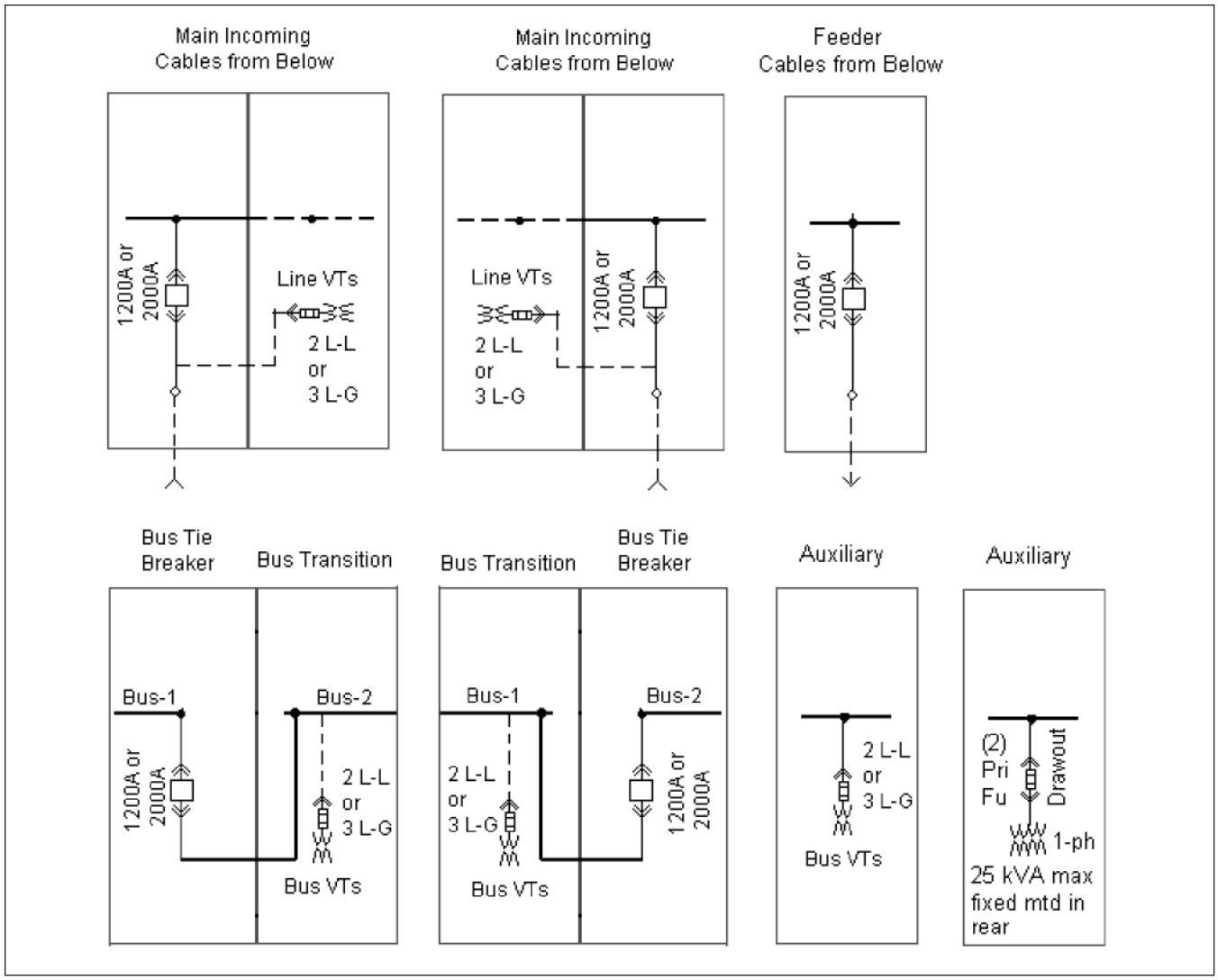


Figure 5.5-67. Typical Arc-Resistant Switchgear Application Layouts—27 kV

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, maximum four per phase.
3. Refer to **Figure 5.5-68** to **5.5-70** for dimensions.
4. 27 kV arc-resistant switchgear can be supplied in one-high design configuration only.

Available Configurations (Continued)

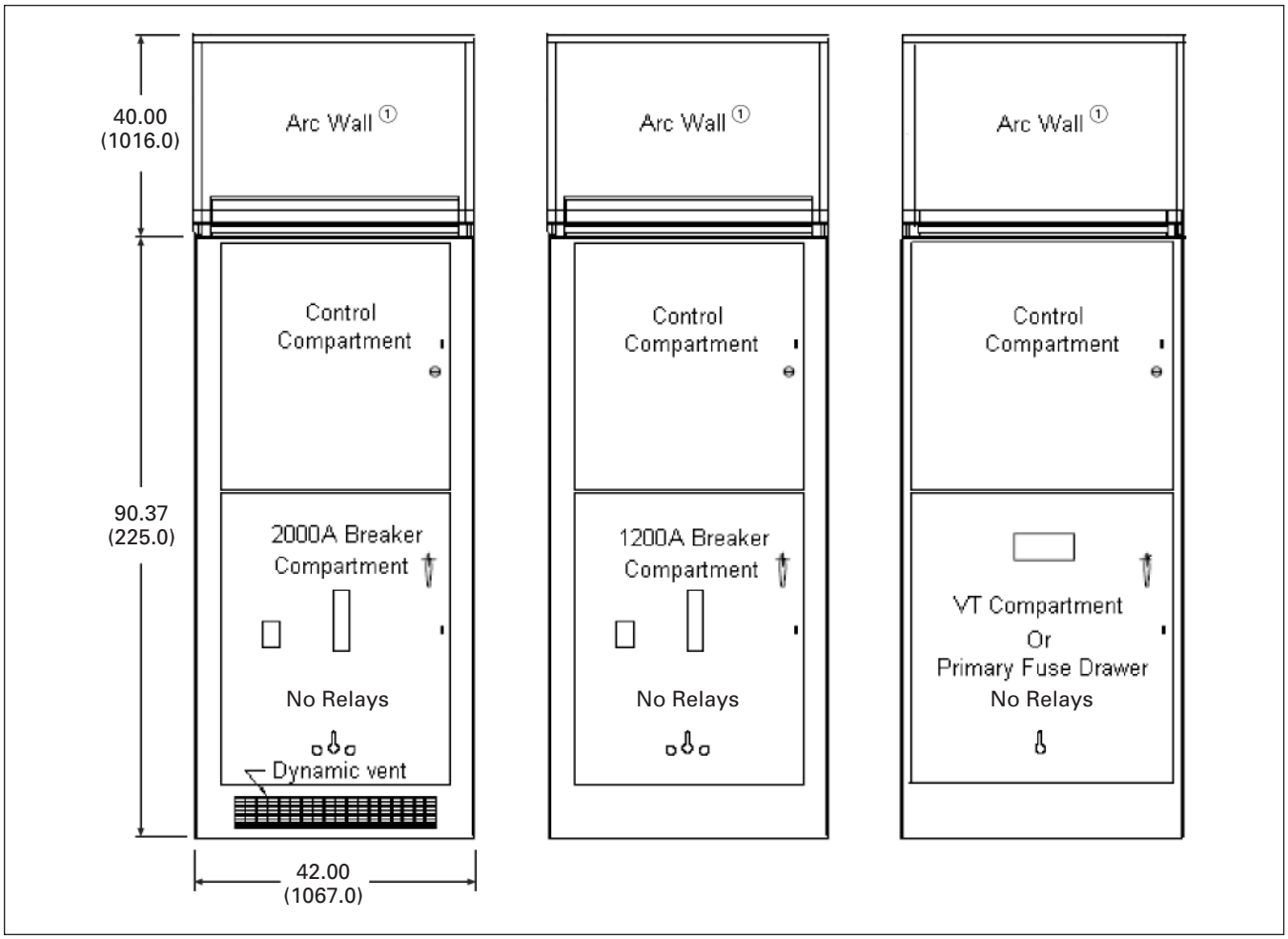


Figure 5.5-68. Available Arc-Resistant Switchgear Configurations (Front Views)—27 kV

① Please note that an additional 48.00-inch (1219.2 mm) clearance is required above the arc wall for arc exhaust.

Typical Weights in Lbs (kg) ②

Table 5.5-15. Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor Structure
Control/breaker	1200 2000	2700 (1226) 2800 (1271)
Control/auxiliary	1200 2000	2400 (1090) 2500 (1135)

② Refer to **Table 5.5-9** for breaker weights.

Typical Sectional Side Views—Dimensions in Inches (mm)

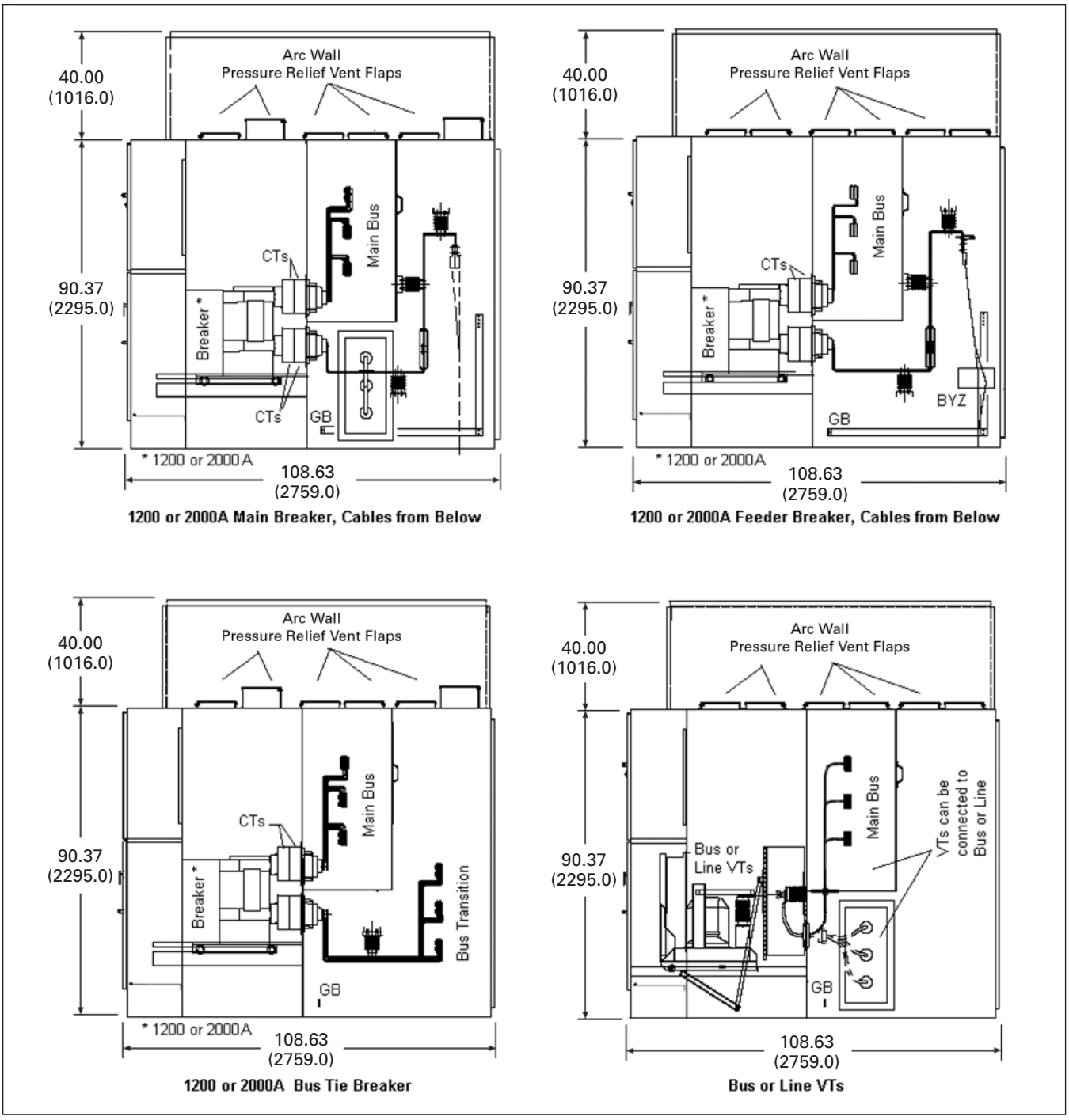


Figure 5.5-69. Typical Arc-Resistant Switchgear Sectional (Side Views)—27 kV

Typical Floor Plan—Dimensions in Inches (mm)

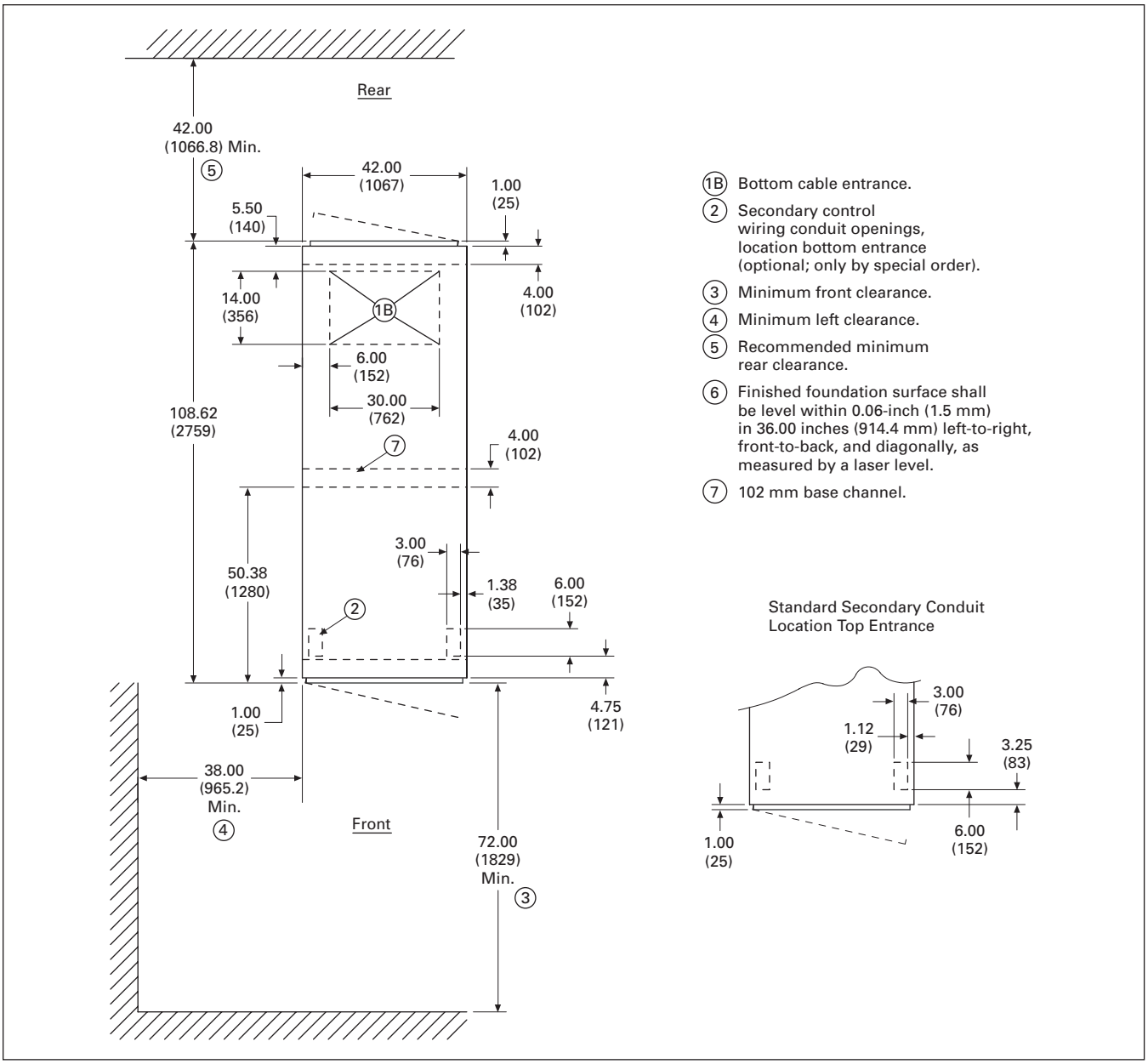


Figure 5.5-70. Typical Arc-Resistant Switchgear Floor Plan—27 kV

Typical Application Layouts

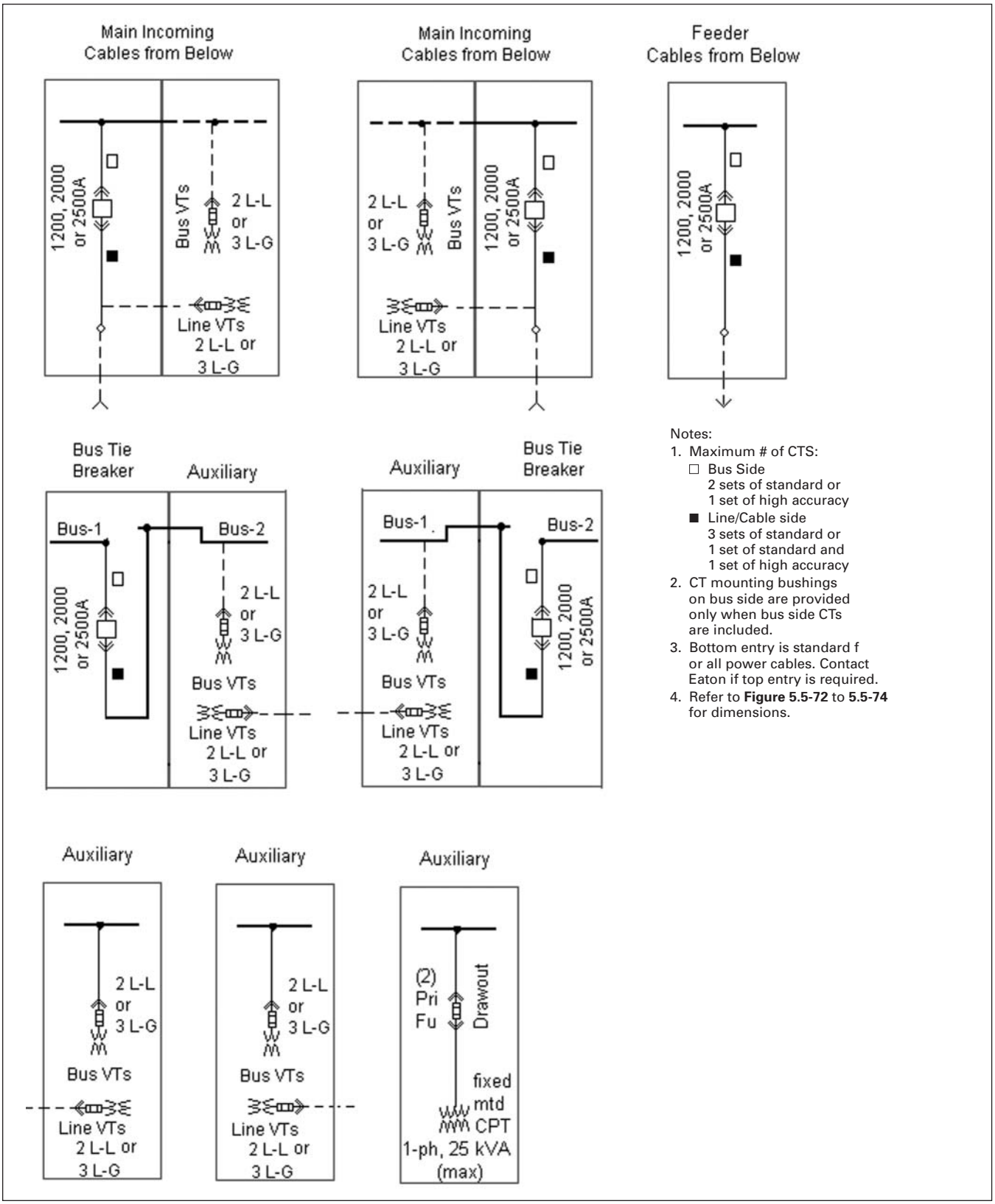


Figure 5.5-71. Typical Arc-Resistant Switchgear Application Layouts—38 kV

Available Configurations

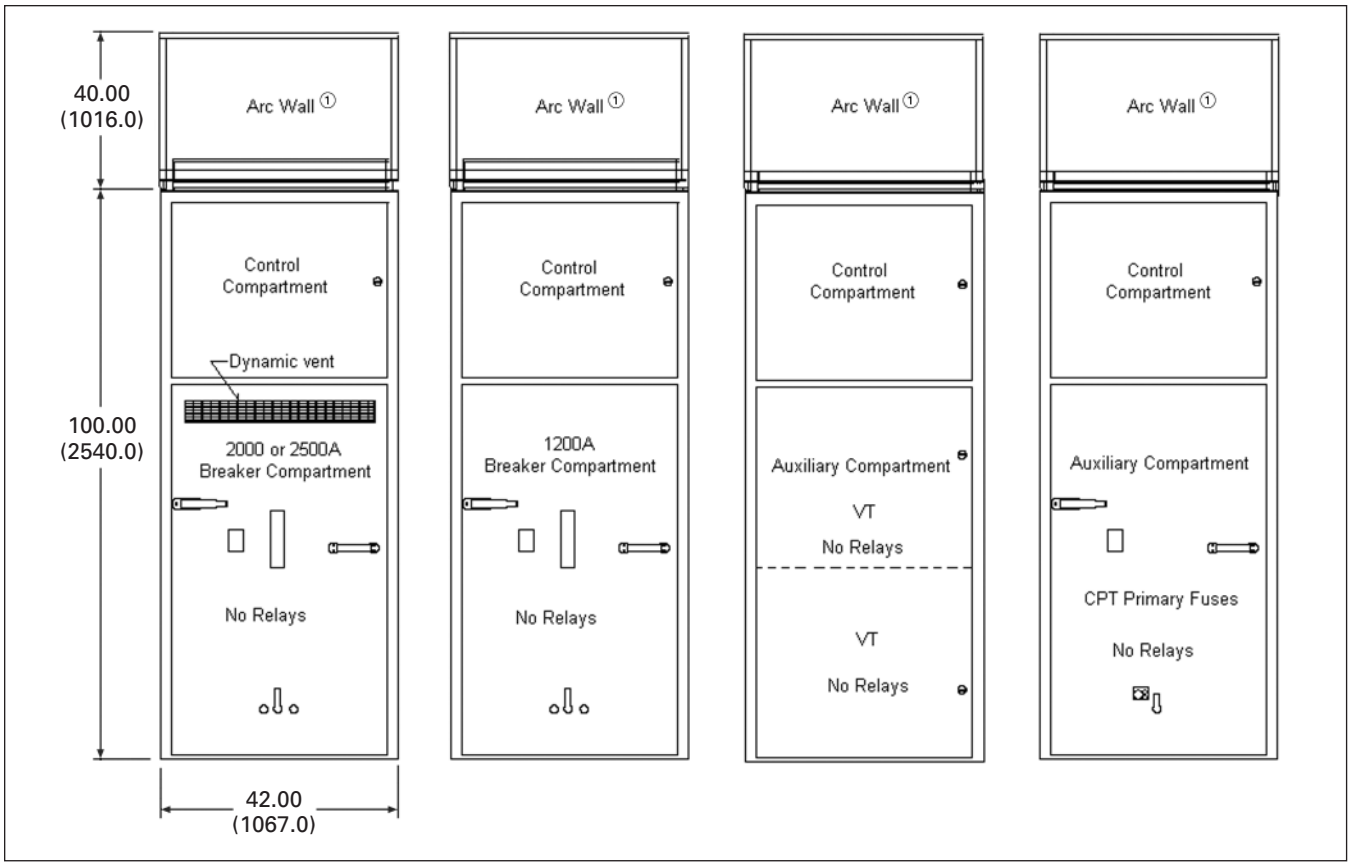


Figure 5.5-72. Available Arc-Resistant Switchgear Application Layouts (Front Views)—38 kV

① Please note that an additional 48.00-inch (1219.2 mm) clearance is required above the arc wall for arc exhaust.

Typical Weights in Lbs (kg) ②

Table 5.5-16. Assemblies (Less Breakers)

Type of Vertical Section	Main Bus Rating Amperes	Indoor Structure
Breaker cell	1200 2000 2500 3000	3500 (1589) 3700 (1680) 4000 (1816) 4000 (1816)
Auxiliary cell	1200 2000 2500 3000	3000 (1362) 3200 (1453) 3500 (1589) 3500 (1589)

② Refer to **Table 5.5-12** for breaker weights.

Typical Sectional—Dimensions in Inches (mm)

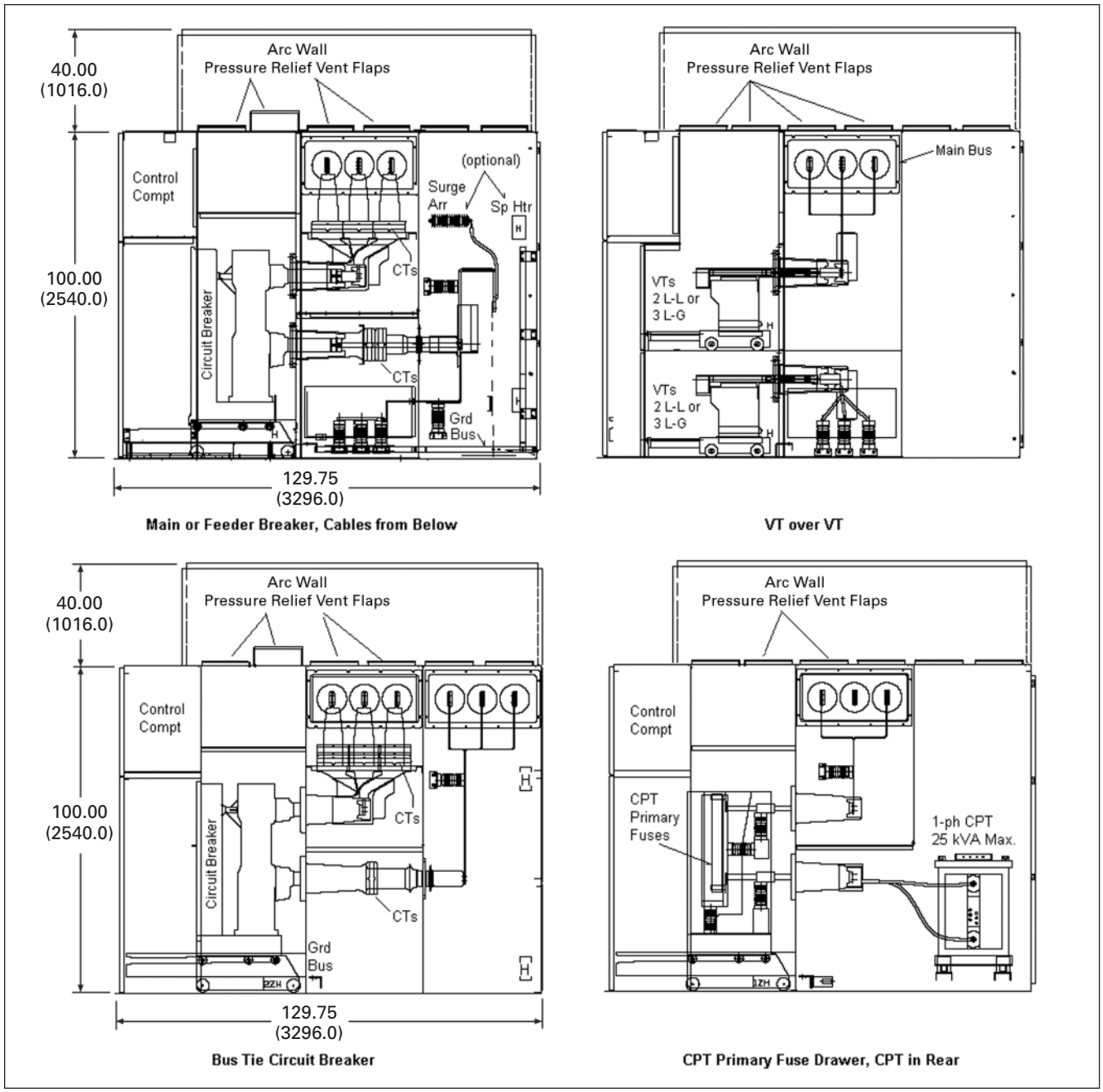


Figure 5.5-73. Typical Arc-Resistant Switchgear Sectional (Side Views)—38 kV

Typical Floor Plan—Dimensions in Inches (mm)

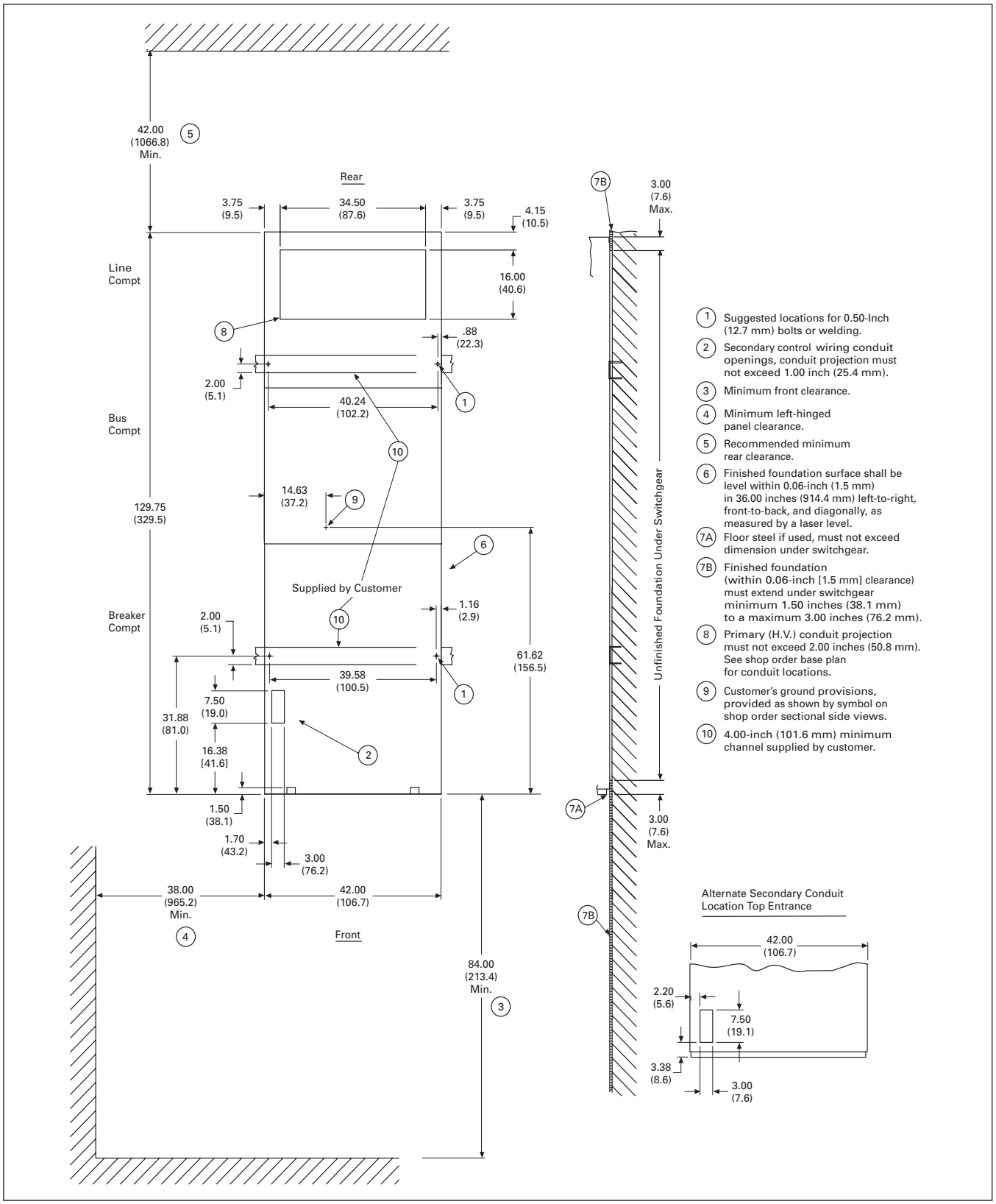


Figure 5.5-74. Typical Arc-Resistant Switchgear Floor Plan—38 kV

Arc Exhaust Wall—for 27 and 38 kV Switchgear

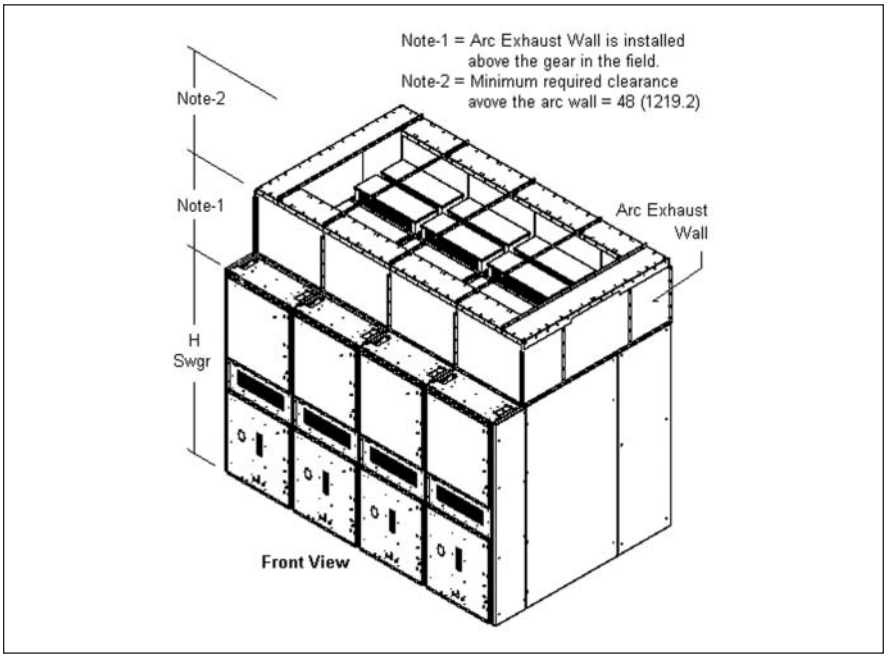


Figure 5.5-75. Arc Exhaust Wall Above the Switchgear

Arc Exhaust wall **Figure 5.5-75** is supplied as standard for all 27/38 kV arc-resistant switchgear. The arc exhaust wall must be field installed above the switchgear. Note minimum 48.00-inch (1219.2 mm) ceiling clearance is required above the arc exhaust wall for proper venting of the arc exhaust. All 5/15 kV arc-resistant switchgear is provided with arc exhaust chamber (plenum). It is also installed in the field. When using arc exhaust chamber, minimum ceiling clearance required above the arc exhaust chamber (plenum) is equal to that needed for field installation of the chamber. Eaton recommends minimum 18.00-inch (457.2 mm). Refer to **Figures 5.5-77** and **5.5-78** for typical arc exhaust chamber (plenum) and arc duct exit arrangements for arc-resistant switchgear installed inside an electrical room and inside an outdoor house.

Arc Exhaust Chamber (Plenum) with Arc Duct Exit—for 5 and 15 kV Switchgear

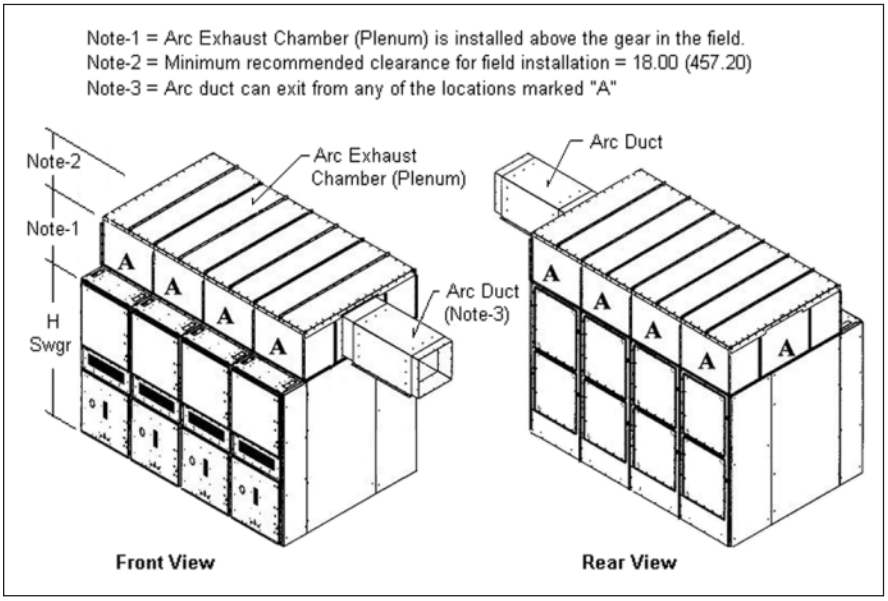


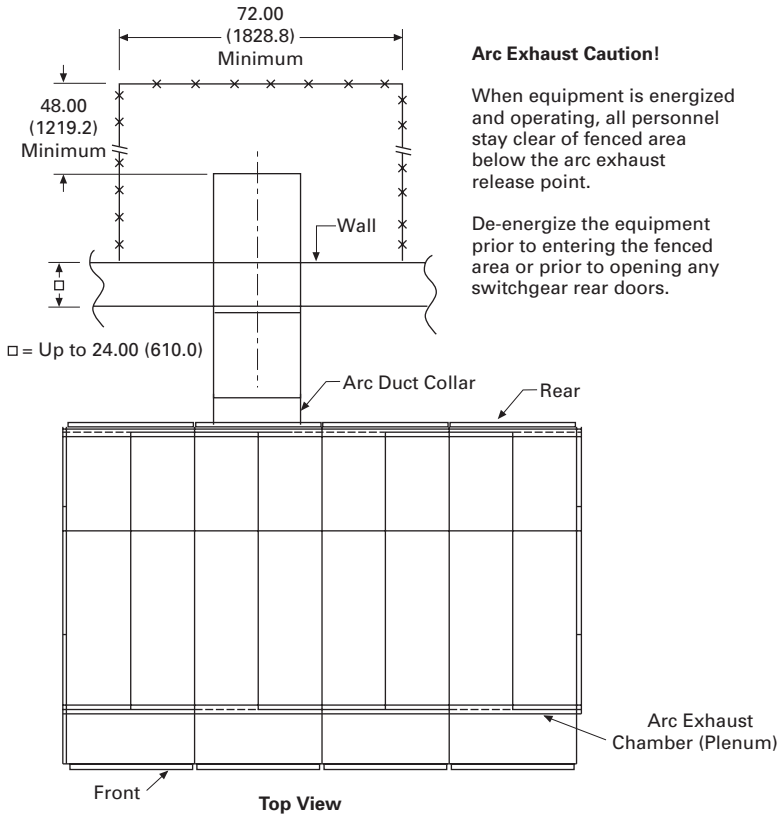
Figure 5.5-76. Arc Exhaust Chamber (Plenum) with Arc Duct Exit Above the Switchgear

Note: APPLICABLE TO ALL ARC-RESISTANT SWITCHGEAR:

For switchgear with enclosure arc ratings of up to 41 kA rms symmetrical, minimum two vertical sections and one arc duct exit is required.

For switchgear with enclosure arc rating of 50 kA rms symmetrical or higher, minimum three vertical sections and two arc duct exits are required.

Typical Layout—Dimensions in Inches (mm)



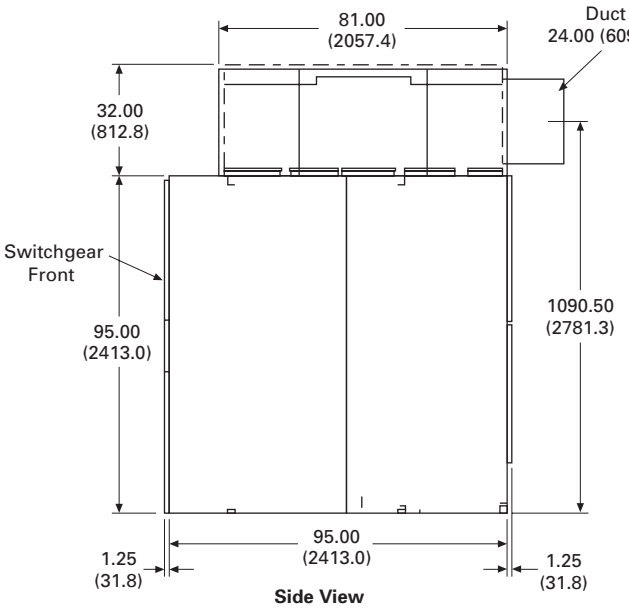
Top View

Typical 5/15 kV Arc-Resistant Switchgear Lineup

Arc Exhaust Caution!

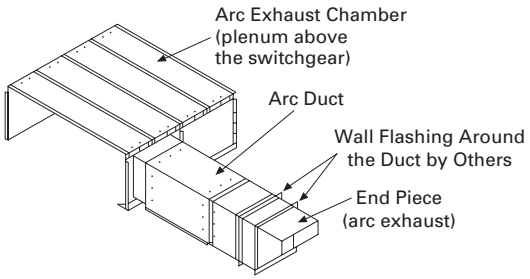
When equipment is energized and operating, all personnel stay clear of fenced area below the arc exhaust release point.

De-energize the equipment prior to entering the fenced area or prior to opening any switchgear rear doors.



Side View

Typical 5/15 kV Arc-Resistant Switchgear



Arc Plenum with Arc Duct Exit
(Partial View)

Figure 5.5-77. Typical Layout of 5/15 kV Arc-Resistant Switchgear Inside Electrical Room and Outside Minimum Exhaust Area

Typical Layout (Continued)

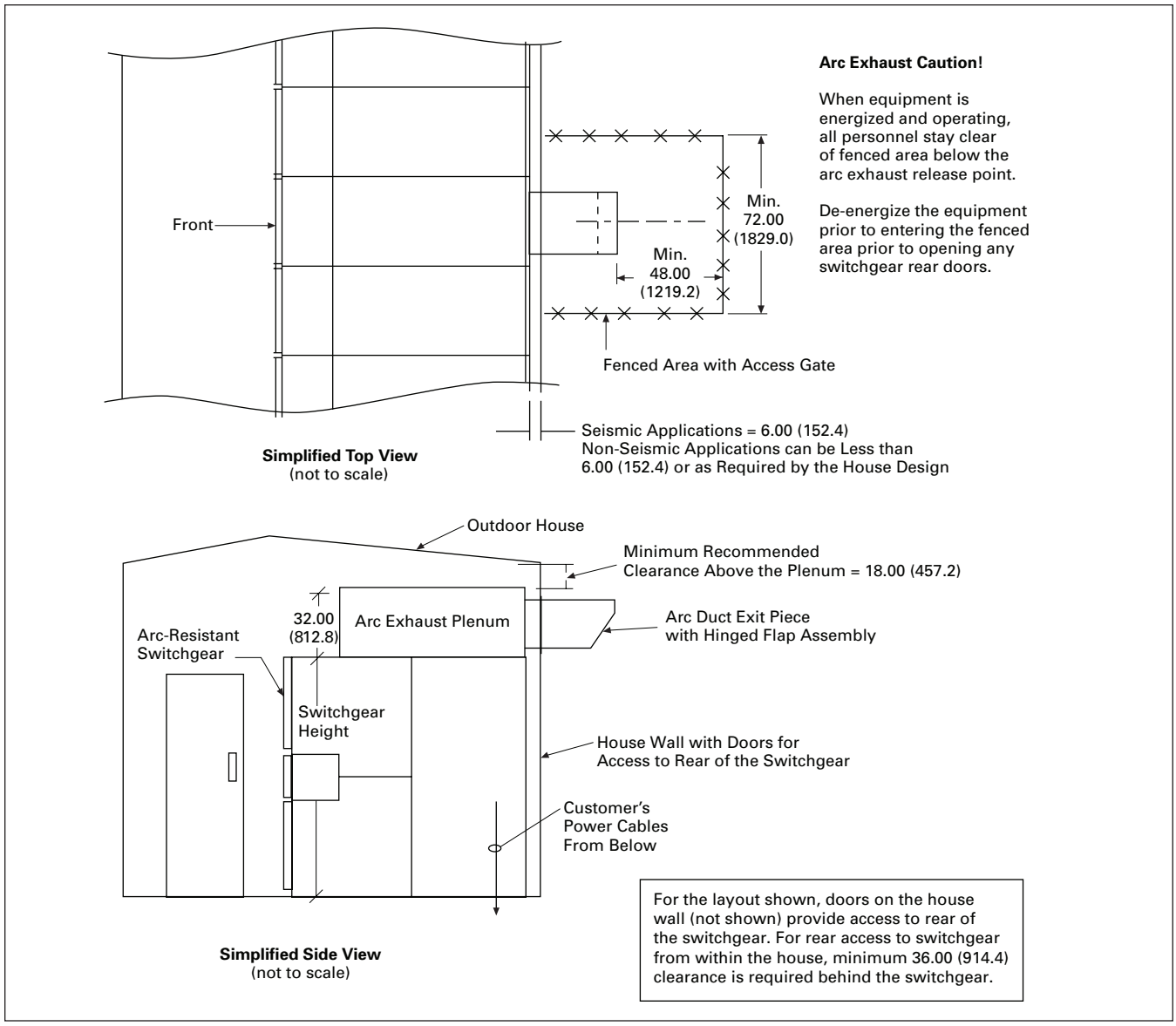


Figure 5.5-78. Typical Layout of 5/15 kV Arc-Resistant Switchgear Inside an Outdoor House (Electrocenter)

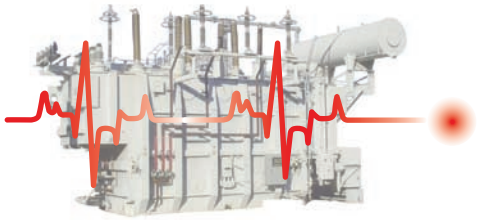
SEL-787 Transformer Protection Relay

SEL Synchrophasors

SEL Advances the State of the Art in Transformer Protection

- **Synchrophasors** detect system oscillations and potential instability.
- **Mirrored Bits® communications** is ideal for teleprotection and remote control applications.
- **Flexible communications** make control integration fast and easy.
- **Small form factor** speeds new installations and retrofits of electromechanical relays.
- **Commissioning Assistant** is the first transformer relaying software that recommends correction settings after identifying errors.

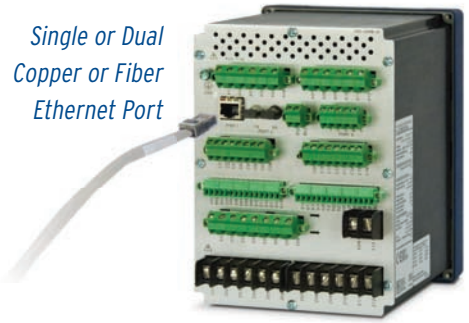
Optimize the Life of Your Transformers by Monitoring Key Health Indicators



Cumulative Through-Fault Current Recording
Measurement and Logic Input

Flexible Communications

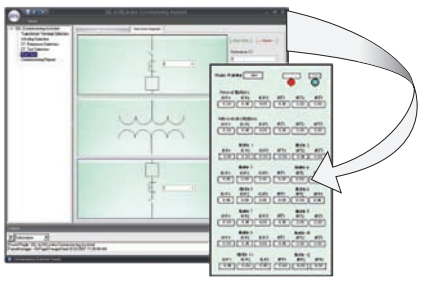
Single or Dual Copper or Fiber Ethernet Port



Three or Four Serial Ports*

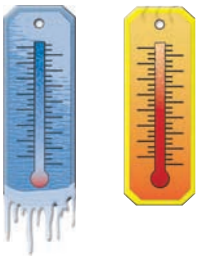
*Optional

Use *Commissioning Assistant* to Easily Generate Differential Compensation Settings



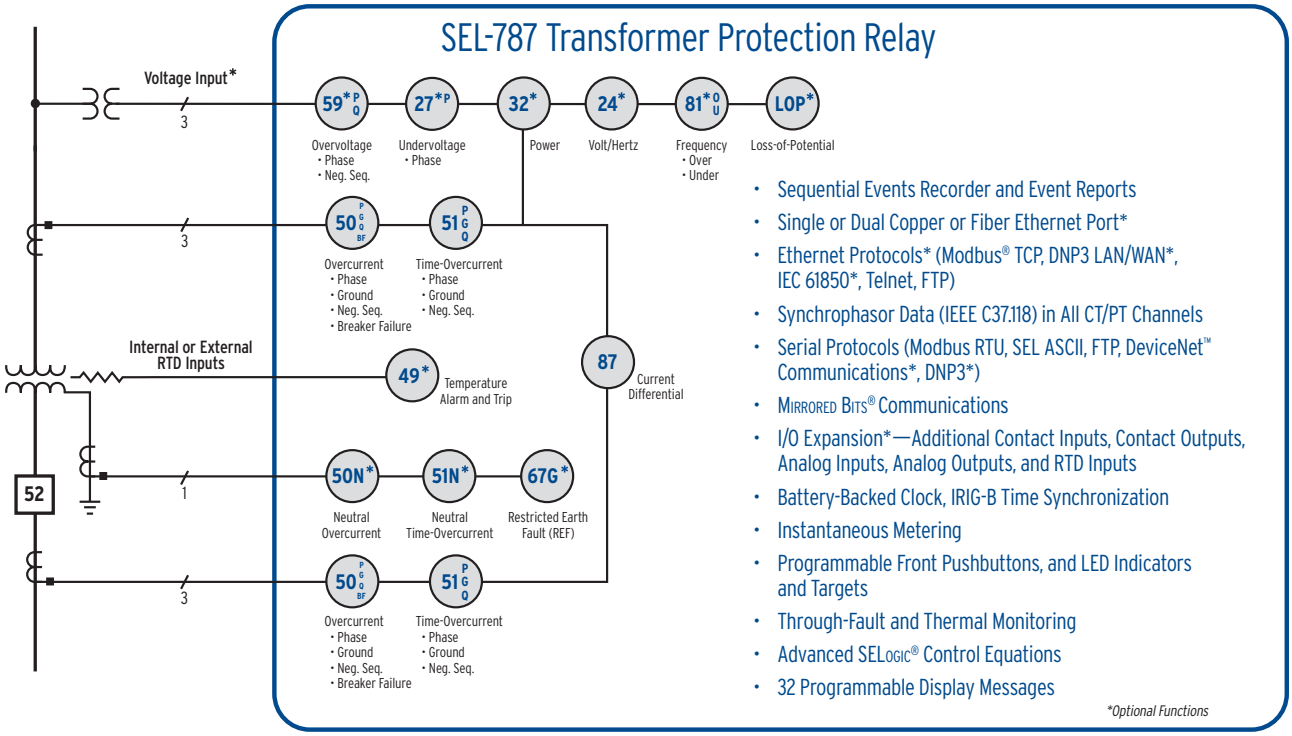
Industry-Leading Quality, Reliability, and Customer Service

−40°C +85°C

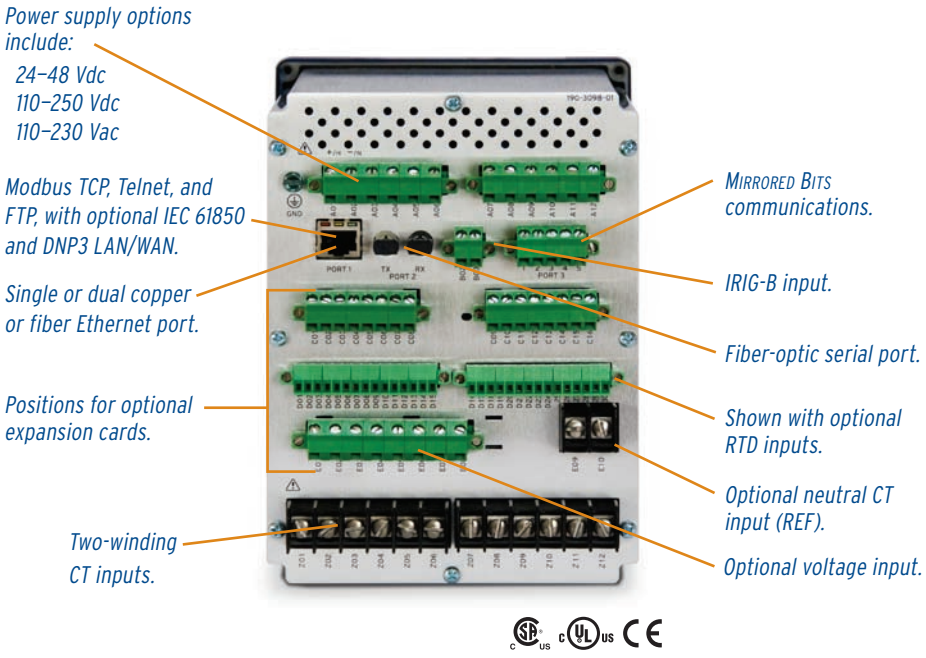


Making Electric Power Safer, More Reliable, and More Economical®

Functional Overview



Feature Overview



Ordering Options

- CPU Board
  - Single or dual copper or fiber Ethernet port
  - EIA-232 or EIA-485 rear port
  - IRIG-B input
- Optional Expansion Cards
  - 3 digital inputs/4 digital outputs/4–20 mA analog output
  - 4 digital inputs/4 digital outputs (electromechanical)
  - 4 digital inputs/4 digital outputs (fast, high-current interrupting)
  - 4 analog inputs/4 analog outputs
  - EIA-232 or EIA-485 serial communication
  - EIA-485 DeviceNet communication
  - 8 digital inputs
  - 10 RTD inputs
  - Neutral ac current input
  - Neutral ac current input/three-phase ac voltage (300 Vac) input
- Conformal Coating

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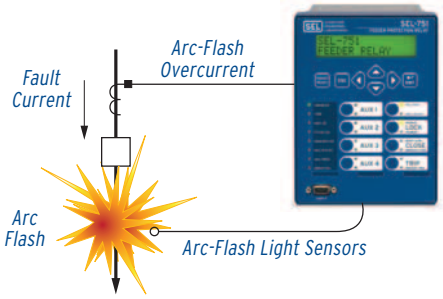
SEL-751 Feeder Protection Relay

Choose the SEL-751 for feeder overcurrent protection with optional directional overcurrent, arc-flash detection, and Arc Sense™ technology.

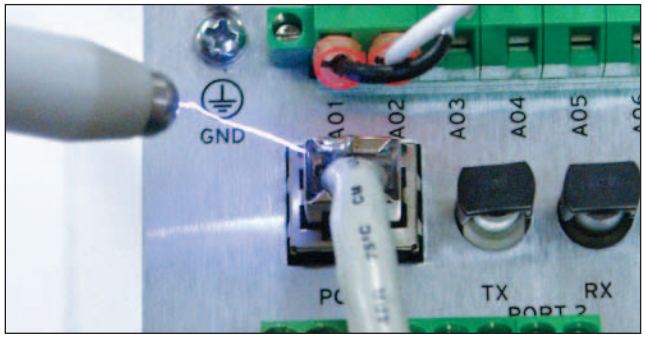
SEL IEC 61850 SEL Synchrophasors®

Detect High-Impedance Faults With Arc Sense Technology

High-Speed Arc-Flash Detection Improves Safety



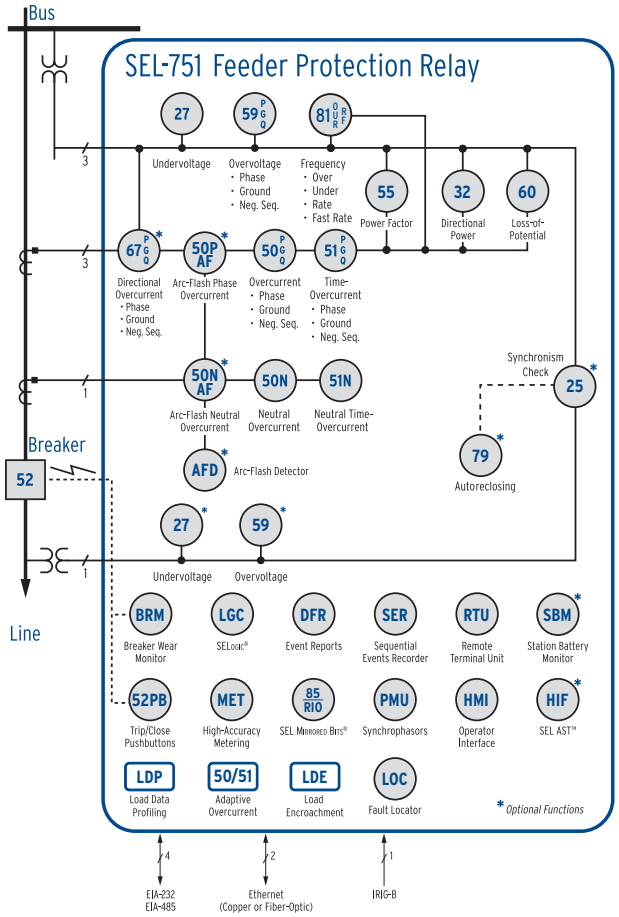
Substation-Hardened Ethernet



Industry-Leading Quality, Reliability, and Service

Making Electric Power Safer, More Reliable, and More Economical®

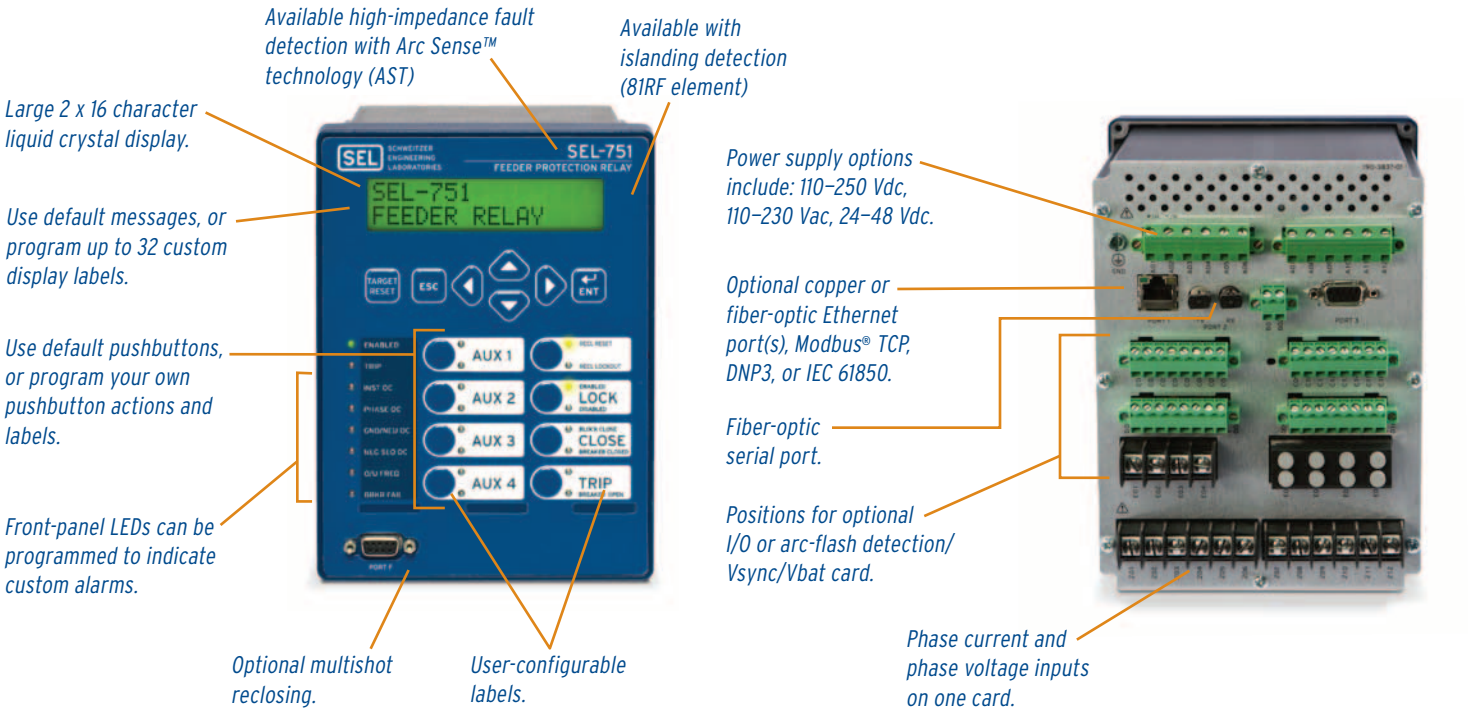
Functional Overview



Ordering Options

- Single or dual, copper or fiber-optic Ethernet port(s)
- Modbus® TCP, DNP3 serial and DNP3 LAN/WAN, FTP, and Telnet protocols
- IEC 61850
- DeviceNet™
- EIA-232 or EIA-485 communications
- Additional EIA-232 or EIA-485 port
- Analog I/O (4 AI/4 AO, 8 AI)
- Digital I/O (4 DI/4 DO, 4 DI/3 DO (2 Form C and 1 Form B), 8 DI, 8 DO, 3 DI/4 DO/1 AO)
- Vsynch and Vbat input card with four arc-flash detection inputs
- 10 RTDs
- Conformal coating for chemically harsh and high-moisture environments
- Multishot reclosing
- Arc Sense technology (AST) for high-impedance fault (HIF) detection
- Directional overcurrent

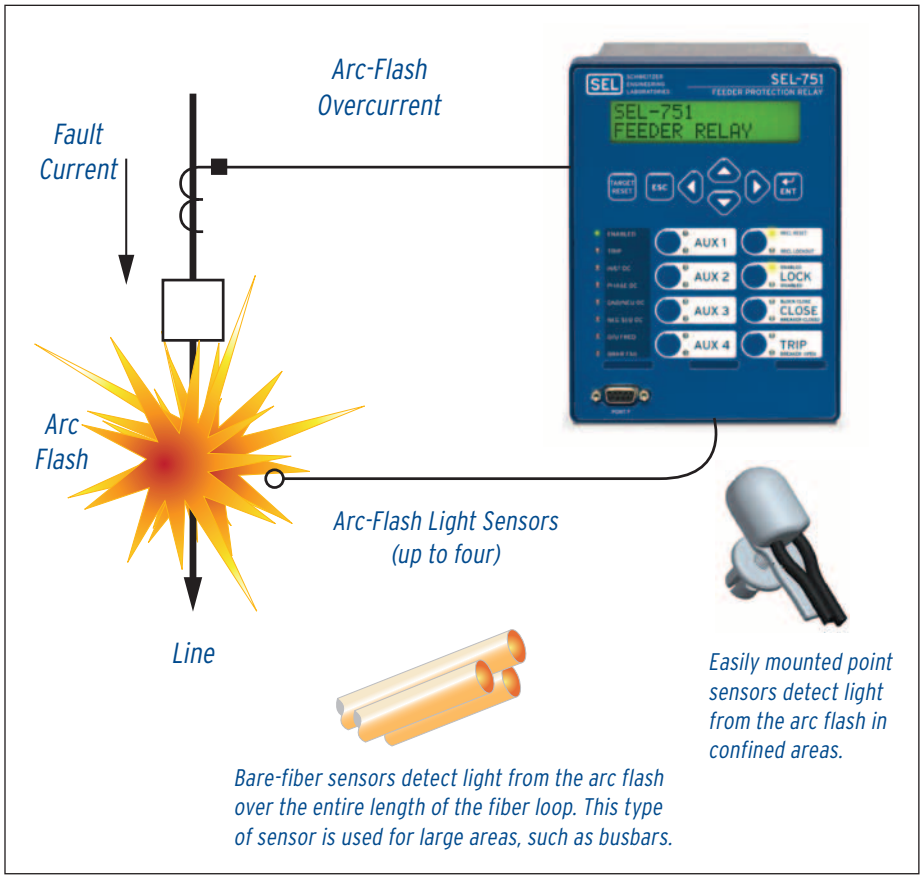
Feature Overview

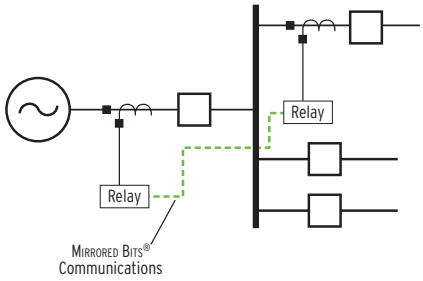


Reduce Arc-Flash Hazards

Combined light-sensing technology with fast overcurrent protection provides high-speed arc-flash detection without false tripping.

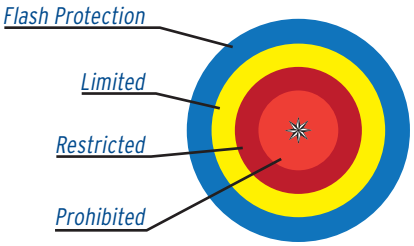
In addition to arc-flash detection, the SEL-751 provides several other methods to limit personnel exposure to arc-flash hazards. Reduce the danger of explosive arc-flash incidents by reducing the available fault current energy or removing personnel from the danger zone. Coordinate protection for faster clearing times, and stay outside the danger zone completely with wireless or remote communications.





Coordinate Protection

Use SEL Mirrored Bits® communications to coordinate upstream protection if a fault occurs. Coordination and fast-bus trip schemes allow short delays (two or three cycles) for backup protection, reducing arc-flash energy.



Stay Outside the Danger Zone

Use Ethernet or serial communications to remotely obtain metering, event, and maintenance information from the relay. Optional delayed breaker tripping or closing via pushbuttons allows personnel to move to a safe distance.

Flexible Communications

Communications Media

- Ethernet 10/100BASE-T
- Ethernet 100BASE-FX
- Single or dual Ethernet ports
- EIA-232 serial
- EIA-485 serial
- Fiber-optic, serial multimode ST®

Communications Protocols

- Mirrored Bits communications
- IEC 61850
- Modbus RTU/TCP
- DNP3 serial, LAN/WAN
- DeviceNet
- Telnet
- FTP
- Synchrophasors (IEEE C37.118)
- SNTP (Simple Network Time Protocol)


Central control room.


Field remote terminal.

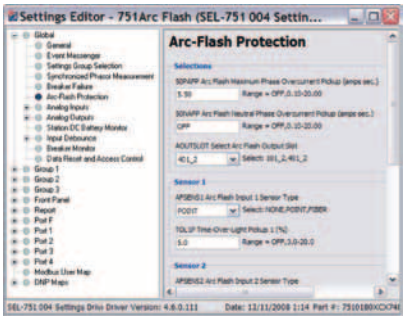

Engineering access.

SEL-751 Feeder Protection Relay

Easy to Set and Use

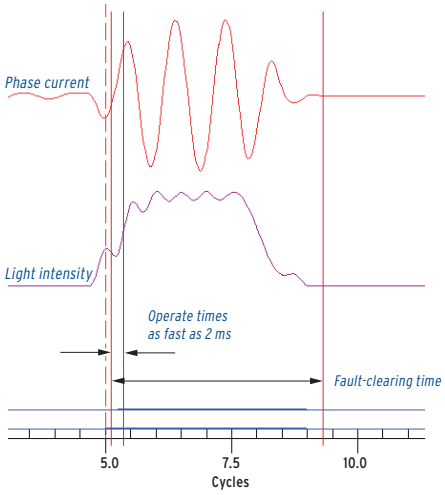
Use ACSELERATOR QuickSet® SEL-5030 Software to set, monitor, and control the SEL-751.

- Save engineering time while keeping flexibility. Communicate with the SEL-751 through any ASCII terminal, or use the ACSELERATOR QuickSet graphical user interface.
- Develop settings offline with a menu-driven interface and completely documented help screens. Speed installation by copying existing settings files and modifying application-specific items.
- Simplify the setting procedure with rules-based architecture to automatically check interrelated settings. Out-of-range or conflicting settings are highlighted for correction.



Use ACSELERATOR Software to retrieve and display event reports recorded by the SEL-751.

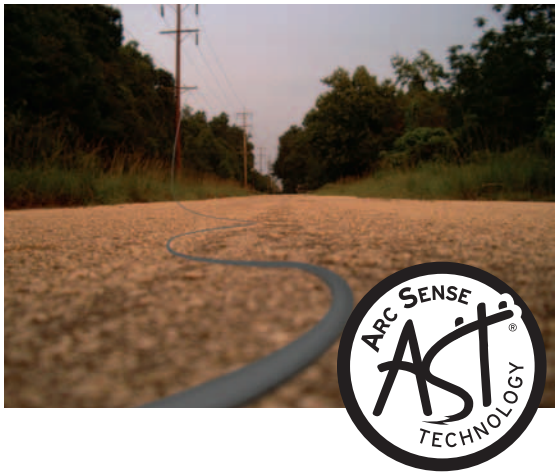
- Display event report oscillograms. View each report as a plot of magnitude versus time. Select analog and digital points to build a custom display. Analyze arc-flash events using light intensity and phase current waveforms recorded during the arc fault.
- Display phase and symmetrical component phasors. Display the phasor view of electrical data to better understand asymmetrical three-phase faults. Build a custom plot using per-phase and symmetrical component sequence currents and voltages.
- Retrieve event reports using serial or Ethernet communications links.

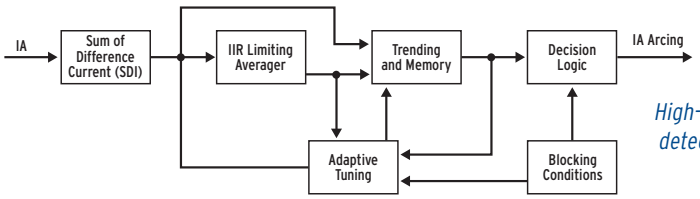


High-Impedance Fault Detection

High-impedance faults and downed conductors on poorly conductive surfaces cause fault current levels too low to be detected by conventional overcurrent protection elements. The SEL-751 with Arc Sense technology (AST) detects many high-impedance faults while maintaining secure protection.

- The SEL-751 with AST is easy to understand, set, and test. SEL offers straightforward protection algorithms with two sensitivity levels and a test mode.
- Never lose an AST event report with an event collection system that automatically transfers event reports to long-term storage. Selectable event report length of 2 to 20 minutes provides the level of detail needed to evaluate downed conductors and high-impedance events.
- Advancements in technology and innovation now make it possible to securely detect many high-impedance faults. However, it is important to educate the public of the dangers associated with downed power lines.





High-impedance fault detection algorithm.

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SEL-587Z

High-Impedance Differential Relay

Bus or Transformer High-Impedance Differential Relay

Apply the SEL-587Z Relay for single-zone bus protection, reactor protection, or sensitive restricted earth fault protection on grounded, wye-connected power transformer windings.

Features and Benefits

Protection

Use high-impedance differential elements for fast tripping for in-zone faults, while providing security during heavy through faults and CT saturation. Reduce panel design cost and space requirements by using a single relay that includes three-phase protection, resistors, and metal oxide varistors (MOVs).

Control

Use front-panel pushbuttons to save the expense of separately mounted control switches. Serial port communication provides for remote control of circuit breakers or other user-defined functions.

Reporting, Monitoring, and Metering

Simplify fault analysis with event reports and Sequential Events Recorder (SER). Validate CT connections using the metered voltage differential quantities.

Communications

Integrate the relay with SCADA, local HMI, or modems using Modbus®, SEL ASCII, and SEL Fast Messaging protocols through the rear-panel isolated communications port. Use the front-panel communications port for relay settings and event report retrieval.

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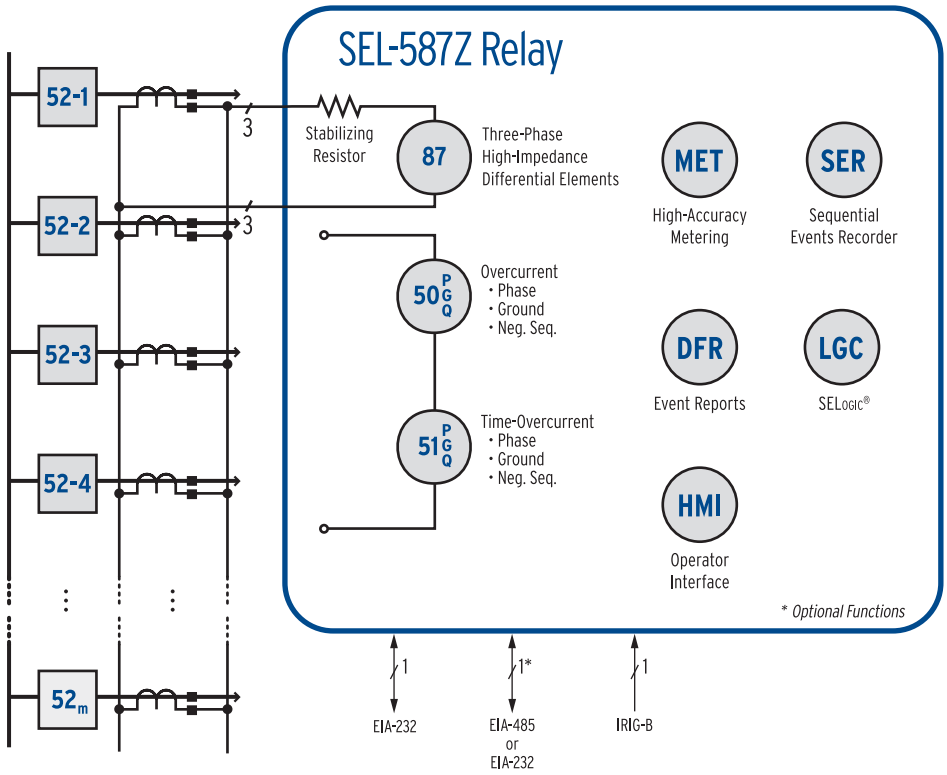
Functional Overview



Differential Protection

The SEL-587Z Relay has three independent high-impedance elements, each with two setting levels, with all differential elements set in volts. As shown below, the faulted-circuit CT can saturate during through faults. High-impedance differential protection offers immunity against relay misoperation resulting from CT saturation, provided that the stabilizing resistor is of sufficiently high value. To comply with this requirement, the SEL-587Z Relay uses 2000-ohm resistors, large enough to provide security against CT saturation for through faults.

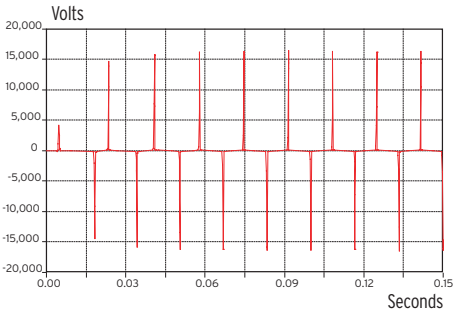
During bus faults, the voltage across the resistor can rise to unacceptably high values if not limited. MOVs in parallel with each high-impedance element clamp the secondary peak voltage to less than 2 kV.

For best performance, select current transformers with fully distributed windings and identical ratios.

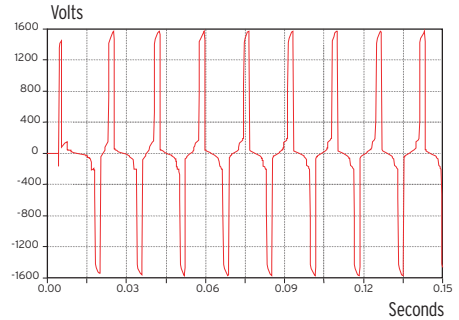
For other SEL-587Z applications that involve mismatched current transformers, contact SEL.

Use the second level of the high-impedance element as a CT open-circuit alarm by configuring the setting with a low value.

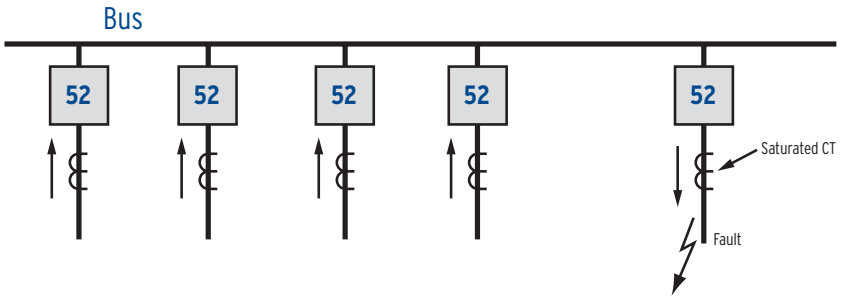
Install the SEL-587Z Relay on transformers with grounded-wye windings for sensitive restricted earth fault protection. The combination of restricted earth fault protection and overcurrent elements will protect smaller transformers where differential protection is not economical.



Voltage without MOV.



MOV-clamped voltage.



Overcurrent Protection

Overcurrent elements include a maximum-phase measurement, phase-specific elements, and negative-sequence and residual overcurrent elements. Use the independent overcurrent elements for protecting other equipment.

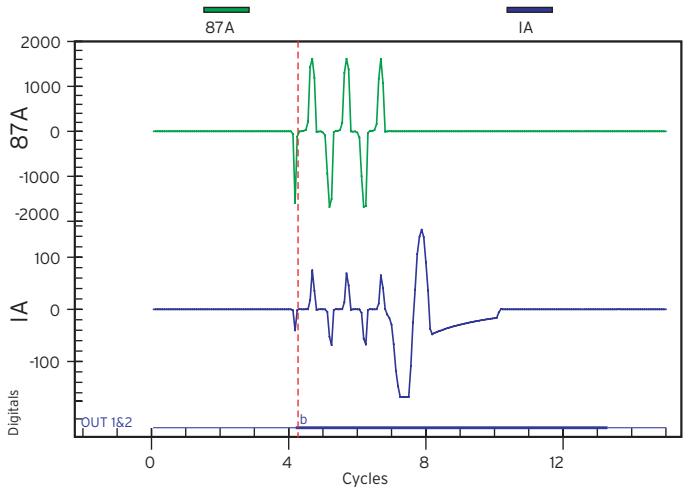
Apply the SEL-587Z overcurrent elements for transformer protection. These elements provide instantaneous overcurrent protection for bushing faults and time-overcurrent protection for coordination with other system protection.

Sequential Events Recorder

Use the time- and date-tagged sequential events messages recorded by the SEL-587Z Relay to analyze the time relationships between assertion and deassertion of logical elements within the relay.

Event Reports

Analyze faults from the event reports, which include 15 cycles of all the analog values measured in the relay as well as most of the digital information. Use ACSELERATOR Analytic Assistant® SEL-5601 Software for a graphical representation of the data.



The first trace is a high-impedance voltage—87A with maximum value about 1600 V. The second trace is a low-impedance current—IA, which represents the total current through the resistor and MOV.

Metering Functions	
Voltage 87A, 87B, 87C	Voltages from each differential element
Current IA, IB, IC, IG, 3I2	Separate phase, negative-sequence, and residual currents
Demand current IA, IB, IC, IG, 3I2	Separate phase, negative-sequence, and residual currents

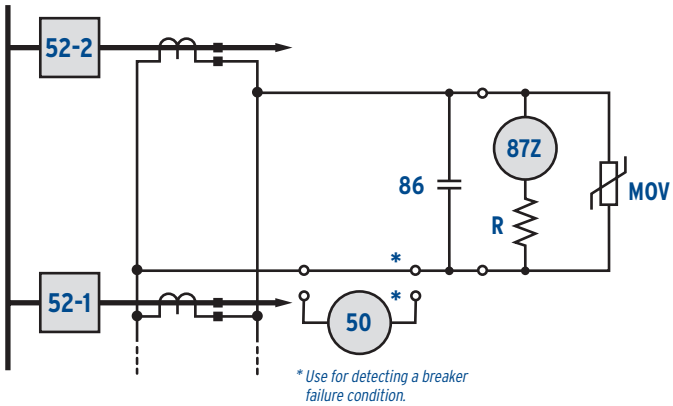
SELOGIC® Control Equations

SELOGIC control equations put relay logic in the hands of the protection engineer. Assign relay inputs to suit the application. Logically combine selected relay elements for various control functions, and assign outputs to logic functions. Eliminate traditional panel control switches with eight local control switches and RTU-to-relay wiring with eight remote control switches. Replace traditional indicating panel lights with eight programmable displays.

Applications

High-Impedance Bus Protection

Use the high-impedance elements 87A1, 87B1, and 87C1 for instantaneous high-impedance bus protection. Set the second level of the high-impedance elements—87A2, 87B2, and 87C2—to lower values to detect CT open-circuit conditions.



87Z – High-Impedance Differential Element

50 – Overcurrent Element

R – 2000 Ω Stabilizing Resistor

86 – Lockout Relay (not included)

MOV – Metal Oxide Varistor

Breaker Failure/Bus Fault Cleared Detection

Apply the 50/51 overcurrent elements in series with the high-impedance elements to detect breaker failure conditions. Following a bus fault, the lockout relay (86) contacts short out the high-impedance elements, and the entire fault current then flows through the 50/51 elements. Delay operation of the 50 element for a suitable period to give all circuit breakers time to open. An element still picked up after the time delay indicates that one or more circuit breakers have failed to open. Use the 50 elements to send a direct transfer trip command to all adjacent substations to clear the fault, or use these elements to supervise SCADA attempts to re-energize the bus.

SEL-587Z High-Impedance Differential Relay

General Specifications

High-Impedance (87A, 87B, 87C)

150 V continuous, linear to 3000 V symmetrical

Burden	2000 Ω stabilizing resistor
Range	20–800 V

MOV clamping voltage

One or two MOV option	2000 V (8 x 20 µs)
Four MOV option	1500 V (8 x 20 µs)

MOV maximum transient energy rating

One MOV—2500 J, two MOV—5000 J, four MOV—8400 J

MOV maximum continuous ac voltage rating

One or two MOV option	750 V
Four MOV option	600 V

AC Current Inputs (IA, IB, IC)

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 625 A for 1 cycle (sinusoidal waveform)

Burden	<0.16 VA @ 5 A; <1.15 VA @ 15 A
Range	0.5–80 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle (sinusoidal waveform)

Burden	<0.06 VA @ 1 A; <0.18 VA @ 3 A
Range	0.1–16 A

Frequency and Phase Rotation

60/50 Hz system frequency and ABC/ACB rotation

Output Contacts (4 plus 1 alarm)

6 A continuous carry, 30 A make per IEEE C37.90: 1989, 100 A for 1 second, 270 Vac/360 Vdc MOV for differential surge protection, pickup/dropout time: <5 ms

Breaking capacity (L/R = 40 ms, 10,000 operations): 0.75 A @ 24 V; 0.5 A @ 48 V; 0.3 A @ 125 V; 0.2 A @ 250 V

Cyclic capacity (L/R = 40 ms, 2.5 cycles per second): 0.75 A @ 24 V; 0.5 A @ 48 V; 0.3 A @ 125 V; 0.2 A @ 250 V

Optoisolated Input Ratings (2 total)

Any of the following nominal voltages: 24, 48, 125, 250 Vdc

Power Supply Ratings

24 V (polarity sensitive)	16–36 Vdc
48/125 V	36–200 Vdc or 85–140 Vac
125/250 V	85–350 Vdc or 85–264 Vac

5.5 W maximum

Serial Communications

One front-panel EIA-232 serial port, one isolated rear-panel EIA-232 or EIA-485 serial port (specify when ordering), data rate: 300, 1200, 2400, 4800, 9600, 19200, and 38400 bps

Time-Code Input

Demodulated IRIG-B accepted at rear-panel serial port

Operating Temperature

–40° to +85°C (–40° to +185°F)

Mounting Options

Horizontal rack-mount and horizontal panel-mount versions available

Production Dielectric Strength Tests

High-impedance and ac current inputs: 2500 Vac for 10 seconds

Power supply, optoisolated inputs, and output contacts: 3100 Vdc for 10 seconds

Cutaway view showing stabilizing resistors and MOVs.

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SERIES 24
INSTRUMENT AND CONTROL SWITCHES

Features

Ordering Information
Switch Diagram

- Double-Sided, Double-Wiping, Knife-Type Rotary Contacts
- Silver Contact Surfaces for Long, Reliable Life
- Terminal Screws – Easy Installation
- Four Hole Mount

Control Switch Special Features

- Spring Return to Normal (Vertical) Position

Instrument Switch Special Features

- Make-Before-Break (Shorting Contacts)
- Common Input Tap Switch Arrangement –– Sequentially Connected to Several Lines Using the Same Switching Deck
- Positive Positioning, Maintained Action Detent Mechanism

Electrical Specifications

Interrupt Ratings

- 15A/120VAC
- 4A/600VAC
- 7.5A/240VAC
- Overload Current (50 operations): 30A/125VAC Resistive
- Voltage Breakdown: 1200V rms minimum
- Insulation Resistance: 100 Megohms minimum
- Contacts Resistance: 10 milliohms maximum

Mechanical Specifications

Sections	1 to 30
Poles	1 to 60
Positions	8; Adjustable Stops for 2–8 Position Rotation
Contacts	Break-Before-Make (Non-Shorting); Make-Before-Break (Shorting)
Action	45° Positive Detent Indexing
Mounting	4-Hole
Panel Thickness	3/16" Max. Standard
Rotor Contacts	Silver Plated Phosphor-bronze, Double Grip
Stationary Contacts	Silver Plated Copper, w/Integral Screw Type Terminals
Construction	Contacts Enclosed in Molded-phenolic Disks

Approvals

- UL File No. E18174
- CSA File #LR20743

Variations

For Key Lock Handle, Key Operated Handle, Solenoid Lock Handle, Push-to-Turn, Spring Return or Waterproof Mount Switches please see page 18.

Model V21.1 – Medium Voltage Potential Transformer
Maximum System Voltage 15.5 kV, BIL 110kV full wave

AMRAN
INSTRUMENT TRANSFORMERS

c UL us E247592

- **UL and cUL Approved (File #E247592)**
- **As per ANSI/IEEE C57.13, IEC, OR relevant standard**

TABLES (Specify Catalog # and Group with the RFQ)

INSULATION LEVEL
15.5 kV, BIL 110 kV full wave

FREQUENCY
60 Hz (50 Hz upon request)

ACCURACY CLASS

0.3WXMYZ, 1.2ZZ @ 100% rated V, 120V based ANSI burden
0.3WXMYZ, 1.2ZZ @ 58% rated V, 69.3V based ANSI burden

THERMAL RATING
1500 VA @ 30 deg. C ambient
1000 VA @ 55 deg. C ambient

OUTER ENCAPSULATION
Resin Encapsulated

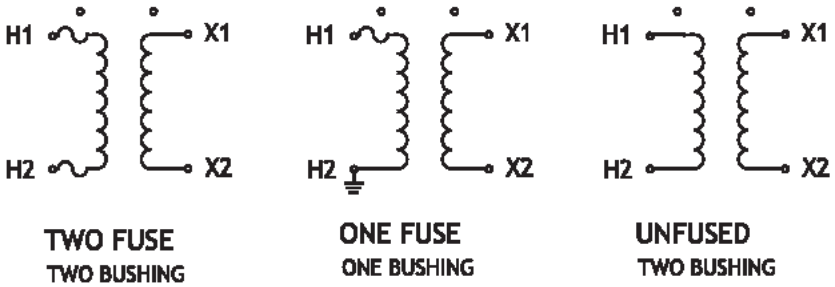
PRIMARY TERMINALS
1/4"-20 Brass screw with one flat washer and lock washer

SECONDARY TERMINALS
M5X0.8 Female Insert, with brass slotted pan head screw, two plain washers and one lock washer

APPROX. WEIGHT
90 lbs.

PLATED STEEL MOUNTING BASE

CUSTOM OPTIONS (CONTACT US)
- Different Ratios, Accuracies
- Non-standard thermal rating
- Different encapsulation
- Different secondary termination
- Special mounting needs etc.



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sales@amranit.com – www.amranit.com

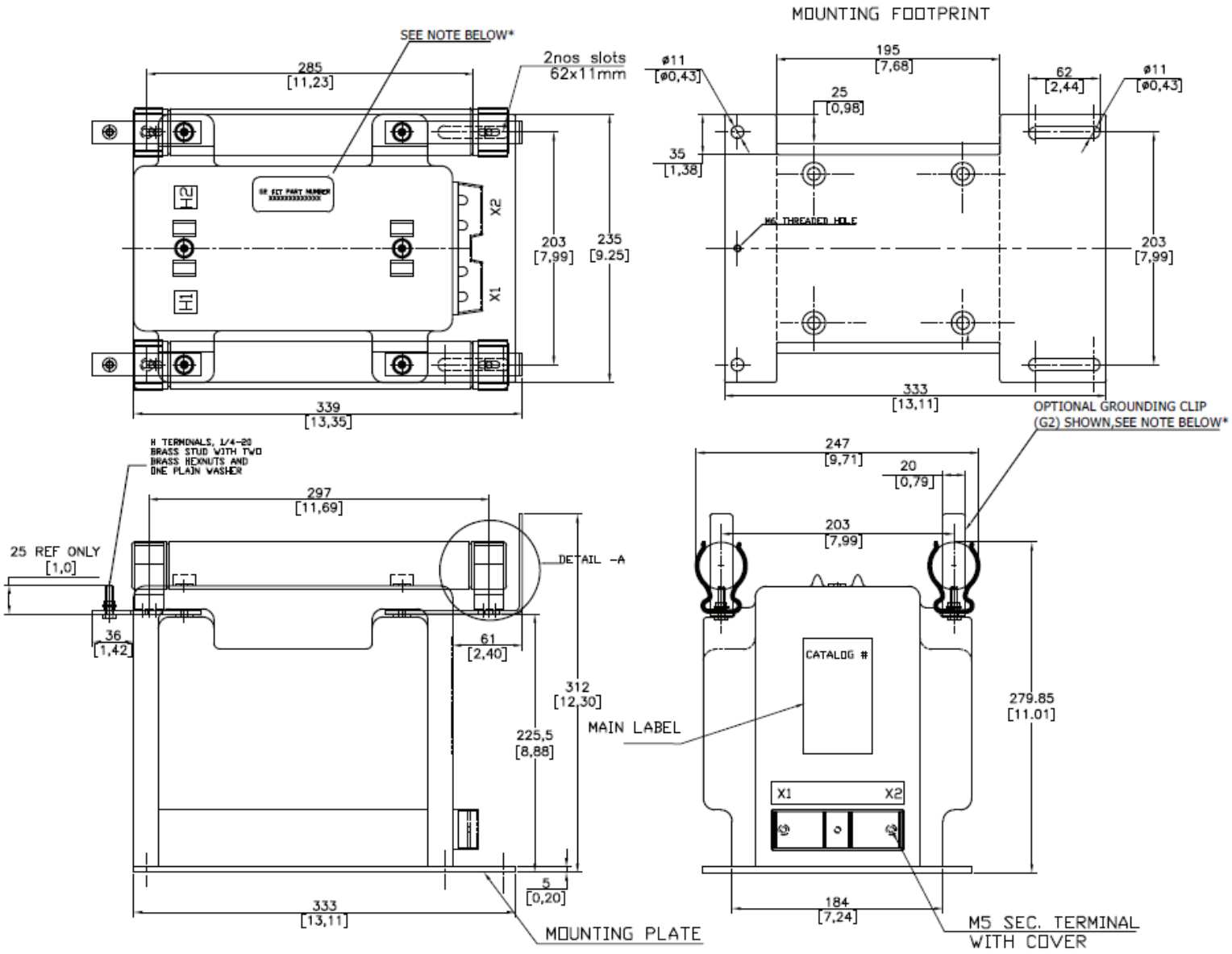
TWO BUSHING						
CATALOG # WITH FUSES	CATALOG # WITHOUT FUSES	CATALOG # WITH FUSES AND GROUNDING CLIPS	GROUP	PRIMARY VOLTAGE	RATIO	SECONDARY VOLTAGE
V21.1-2-242FF	*V21.1-2-242NF	V21.1-242FFG2	1	2400	20:1	120
V21.1-2-422FF	*V21.1-2-422NF	V21.1-422FFG2	1	4200	35:1	120
V21.1-2-482FF	*V21.1-2-482NF	V21.1-482FFG2	1	4800	40:1	120
V21.1-2-662FF	*V21.1-2-662NF	V21.1-662FFG2	1	6600	60:1	110-50Hz
V21.1-2-722FF	*V21.1-2-722NF	V21.1-722FFG2	1	7200	60:1	120
V21.1-2-842FF	*V21.1-2-842NF	V21.1-842FFG2	1	8400	70:1	120
V21.1-2-113FF	*V21.1-2-113NF	V21.1-113FFG2	2	11000	100:1	110-50Hz
V21.1-2-123FF	*V21.1-2-123NF	V21.1-123FFG2	2	12000	100:1	120
V21.1-2-12471FF	*V21.1-2-12471NF	V21.1-12471FFG2	2	12470	104:1	120
V21.1-2-1322FF	*V21.1-2-1322NF	V21.1-1322FFG2	2	13200	110:1	120
V21.1-2-1382FF	*V21.1-2-1382NF	V21.1-1382FFG2	2	13800	115:1	120
V21.1-2-1442FF	*V21.1-2-1442NF	V21.1-1442FFG2	2	14400	120:1	120

SINGLE BUSHING						
CATALOG # WITH FUSE	CATALOG # WITHOUT FUSES	CATALOG # WITH FUSES AND GROUNDING CLIPS	GROUP	PRIMARY VOLTAGE	RATIO	SECONDARY VOLTAGE
V21.1-242F	*V21.1-242NF	V21.1-242FG1	4A	2400	20:1	120
V21.1-422F	*V21.1-422NF	V21.1-422FG1	4A	4200	35:1	120
V21.1-482F	*V21.1-482NF	V21.1-482FG1	4A	4800	40:1	120
V21.1-722F	*V21.1-722NF	V21.1-722FG1	4A	7200	60:1	120
V21.1-7621F	*V21.1-7621NF	V21.1-7621FG1	4A	7620	63.5:1	120
V21.1-7971F	*V21.1-7971NF	V21.1-7971FG1	4A	7970	66.4:1	120
V21.1-842F	*V21.1-842NF	V21.1-842FG1	4A	8400	70:1	120
V21.1-113F	*V21.1-113NF	V21.1-113FG1	4B	11000	100:1	110-50Hz
V21.1-123F	*V21.1-123NF	V21.1-123FG1	4B	12000	100:1	120
V21.1-12471F	*V21.1-12471NF	V21.1-12471FG1	4B	12470	104:1	120
V21.1-1322F	*V21.1-1322NF	V21.1-1322FG1	4B	13200	110:1	120
V21.1-1382F	*V21.1-1382NF	V21.1-1382FG1	4B	13800	115:1	120
V21.1-1442F	*V21.1-1442NF	V21.1-1442FG1	4B	14400	120:1	120

***Contact Amran for the unfused version drawing**

DIMENSIONS: Dimensions are in mm [inches]

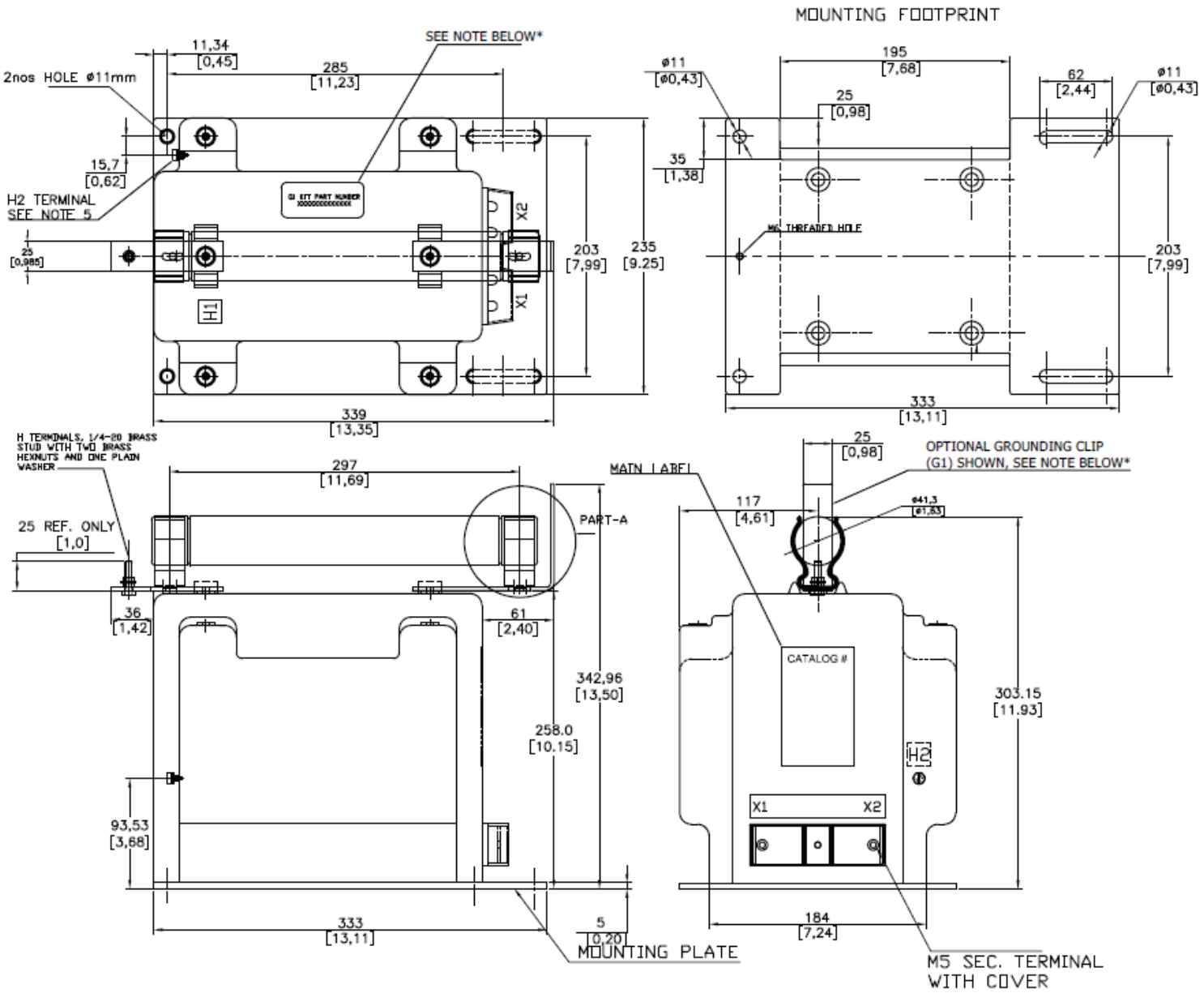
TWO BUSHING, TWO FUSE



- *Units with optional grounding clips (G2) as shown have the additional label with the corresponding G2 part number listed
- Standard Fuse:
  - 15.5kV, 1.0E fuse for primary voltages below 10kV
  - 15.5kV, 0.5E fuse for primary voltages above 10Kv
- Fuse clips accept 1.63” diameter fuses with Max. length of 12.87”
- Fuses are intended to protect the system and not the PT in the event of a failure

DIMENSIONS: Dimensions are in mm [inches]

SINGLE BUSHING, ONE FUSE



- *Units with optional grounding clips (G1) as shown have the additional label with the corresponding G1 part number listed.
- Standard Fuse:
  - 15.5kV, 1.0E fuse for primary voltages below 10kV
  - 15.5kV, 0.5E fuse for primary voltages above 10kV
- Fuse clips accept 1.63” diameter fuses with Max. length of 12.87”
- Fuses are intended to protect the system and not the PT in the event of a failure

AMRAN
INSTRUMENT TRANSFORMERS

E205113 231838

- **UL, cUL Recognized and CSA Certified**
- **As per ANSI/IEEE C57.13, IEC, OR relevant standard**

INSULATION LEVEL
600 V; BIL 10kV full wave

FREQUENCY
50-400 Hz

THERMAL RATING

600:5MR – 3000:5MR	2.0 @ 30 deg. C ambient
	1.5 @ 55 deg. C ambient
4000:5MR	1.5 @ 30 deg. C ambient
	1.33 @ 55 deg. C ambient

OUTER ENCAPSULATION
Plastic Cased

SECONDARY TERMINALS
Brass screw # 10-32 with one flat washer and lock washer, accessible from either side

APPROX. WEIGHT
31 lbs.

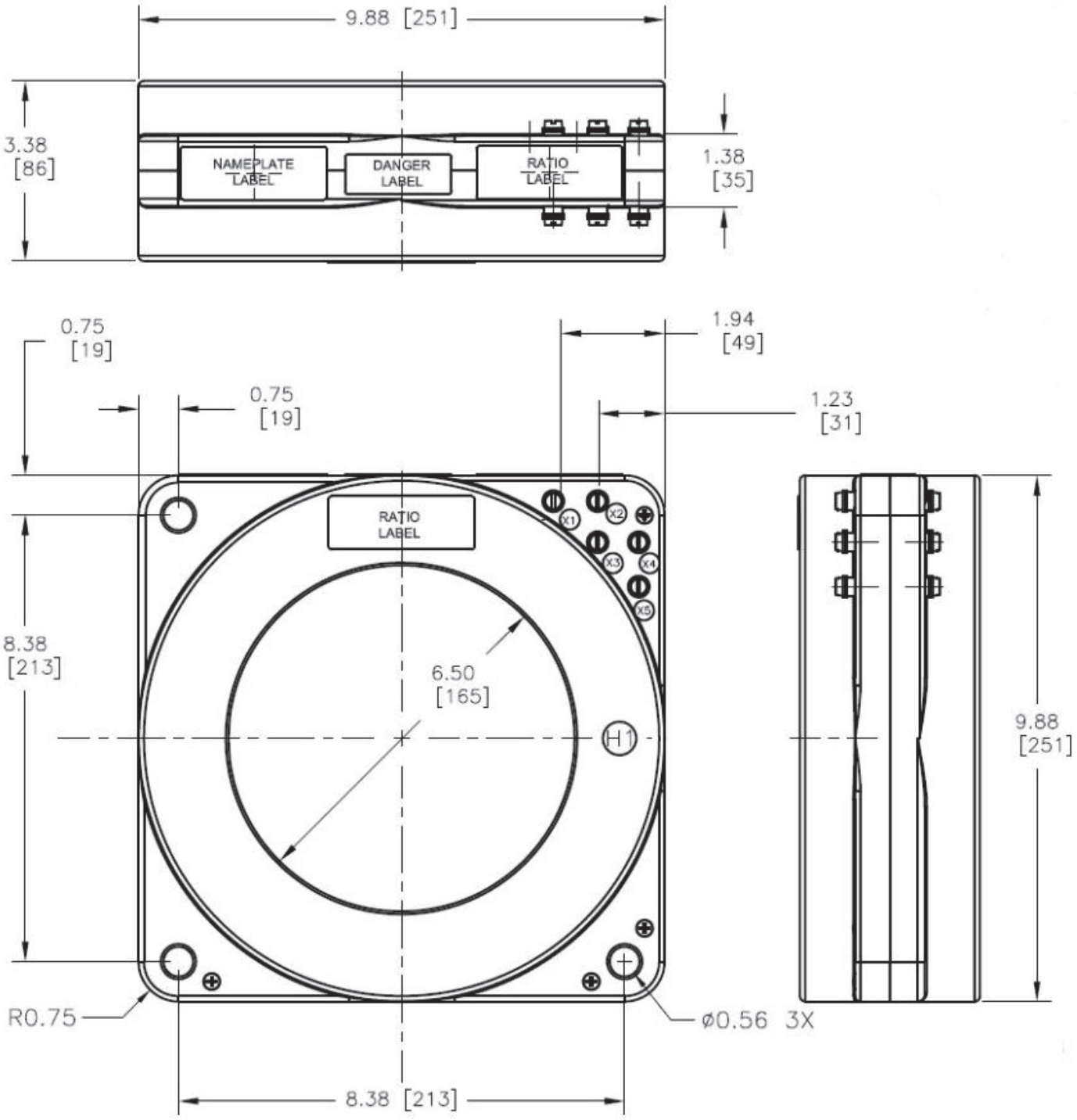
CUSTOM OPTIONS (CONTACT US)
- Different Ratios
- Non-standard thermal rating
- Different encapsulation
- Different secondary termination
- Special mounting needs

TABLES

Catalog #	Current Ratio	ANSI Relay Accuracy	ANSI Metering Accuracy (60Hz)
CT102-601MR	600:5 MR	C100	0.6B1.8
CT102-122MR	1200:5 MR	C200	0.3B1.8
CT102-202MR	2000:5 MR	C200	0.15B1.8
CT102-302MR	3000:5 MR	C200	0.15B1.8
CT102-402MR	4000:5 MR	C200	0.15B1.8

Turns				
MR	X1-X2	X2-X3	X3-X4	X4-X5
600:5	20	10	50	40
1200:5	40	20	100	80
2000:5	80	160	60	100
3000:5	200	240	60	100
4000:5	100	300	200	200

DIMENSIONS (ALL DIMENSIONS ARE IN INCHES:



EXCITATION CURVES:

Available upon request: