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VacClad-W Arc-Resistant Metal-Clad Switchgear

VacClad-W Standard Metal-Clad Switchgear

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

Continuous Current—Main Bus:
- 1200 A, 2000 A, 3000 A (5 and 15 kV)
- 4000 A (5 and 15 kV)
- 1200 A, 2000 A, 2500 A, 2700 A (27 kV)
- 3000 A (27 kV arc resistant)
- 1200 A, 2000 A, 2500 A (38 kV)
- 3000 A (38 kV arc resistant)

Note: Continuous currents above 4000 A, contact Eaton.

Certifications

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

Advantages

Eaton has been manufacturing metal-clad switchgear for over 60 years, and vacuum circuit breakers for more than 40 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. The light weight of the VacClad-W simplifies handling and relocation of the breakers.
Metal-Clad Switchgear—VacClad-W—Medium-Voltage Drawout Vacuum Breakers

General Description

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 Table 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.

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 leveraging 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
- 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

Front-Accessible Stored Energy Mechanism
Breaker Operations Counter
Breaker Main Contacts Open/Closed Status
Manual Push-to-Close & Open Pushbuttons

Glass Polyester Insulator
Vacuum Interrupter Pole Unit
Manual Spring Charging Port
Spring Charged/Discharged Status

Type VCP-W 27 kV Circuit Breaker—Side View

Epoxy Insulator
Primary Disconnect

Type VCP-W 38 kV Circuit Breaker—Front View

Front-Accessible Stored Energy Mechanism
Control Panel (Breaker Functions and Indicators)
Code Plates

Type VCP-W 38 kV Circuit Breaker—Rear View

Primary Disconnect
Pole Unit
Vacuum Interrupter Located Inside this Molded Epoxy Housing
Insulation Shrouds
Alignment Rollers
Breaker Wheel

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)
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.

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.

- 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.

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

Type VCP-W Metal-Clad Switchgear Assembly (5/15 kV Shown)
Roll-on-the-Floor Breaker Option

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

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

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

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, 1200 A, 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, 1200 A maximum, with rated main bus of 1200 or 2000 A. For installations requiring 2000 A main breakers with 1200 A 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 made 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 single-phase control power transformers 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 5.5-11 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 E-Series relays and Power Xpert® meters are recommended for reduced panel space.

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 1200 A 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 5.5-11 for available configurations, dimensions and weights.

For more information, visit: www.eaton.com/consultants
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—1200 A, 2000 A
  - Switchgear main bus—
    - One-high design: 1200 A, 2000 A
    - Two-high design: 1200 A, 2000 A, 2500 A, 2700 A

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 45 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
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.

**Ratings**
- Maximum rated voltage: 38 kV rms
- BIL withstand: 150 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 2500 A Switchgear main bus—up to 3000 A

**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

**Control**
- **Compartment**
- **Type VCP-W Roll-on the Floor Drawout Circuit Breaker**
- **Breaker Compartment Door**
- **Control Panel (Breaker Functions and Indicators)**
- **Contact Erosion Indicator**
- **Secondary Contact Block**
- **Lift/Pull Handle**
- **Code Plates**
- **Guide Rails Ensure Breaker/Cell Alignment**

**38 kV Breaker—Fully Withdrawn**
- **38 kV Breaker—Rear View**
- **Primary Disconnect**
- **Pole Unit**
- **Vacuum Interrupter Located Inside this Molded Epoxy Housing**
- **Insulation Shrouds**
- **Alignment Rollers**

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### 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

### 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 150 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
- 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
Features—38 kV Switchgear
Assembly (Continued)

■ 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

■ Each 38 kV 150 kV BIL indoor structure is 42.00 inches (1066.8 mm) wide x 95.00 inches (2413 mm) high x 124.36 inches (3158.8 mm) deep. Also available are outdoor aisleless and outdoor sheltered aisle structures

■ 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
38 kV, 150 kV BIL Design—Available Enclosures (42-Inch, 48-Inch and 60-Inch Wide Structures are Available)
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Arc-Resistant Metal-Clad Switchgear Medium-Voltage

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.

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.)

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

Medium-Voltage Vacuum Circuit Breaker Features and Ratings

VacClad-W metal-clad arc-resistant switchgear is designed for use with Eaton’s state-of-the-art medium-voltage vacuum type VCP-W (standard ANSI), VCP-WC (extra capability), and VCP-WG (generator) circuit breakers. Refer to 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 over-pressure, fire, smoke, gases and molten material out of the assembly without affecting structural integrity, and protect personnel who might be present in the vicinity of the switchgear
- The structure roof, including the pressure release flap vents, is drip proof. The design is made strong such that the roof can be “walked-on” when the gear is completely de-energized (for example, during installation)
- Since arc pressure is vented out through the top of each individual vertical section, the equipment damage is confined to individual structures, minimizing damage to adjacent structures

Circuit Breaker Compartment

- The levering mechanism is mechanically interlocked with the compartment door such that the door cannot be opened until the circuit breaker is opened and levered out to the test/disconnect position. This interlocking ensures that the levering of the circuit breaker into or out from the connected position is done with compartment door closed and latched, with no exposure to potential arc flash
- Easy access and viewing ports are provided on the door to allow operator to carry out normal functions with the door closed and latched, with no exposure to potential arc flash. Those functions include: Breaker levering and manual opening of the circuit breaker, viewing of open/close status of the breaker main contacts, viewing of charged/discharged status of the closing springs, viewing of mechanical operations counter, and breaker position

Auxiliary Compartments

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

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

Control Compartments

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

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

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

Arc Exhaust Wall and Arc Exhaust Chamber (Plenum)

Refer to Page 5.5-41.
5/15 kV Arc-Resistant Switchgear

Note: Application layouts and dimensions—refer to Pages 5.5-21 to 5.5-31 and Pages 5.5-41 to 5.5-43.
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 5.5-33 to 5.5-36 and Pages 5.5-41 to 5.5-43.
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

Rear Assembly

Control Compartment

Main Bus Cover

Main Bus (Shown with Cover Removed)

VT Drawer

Primary Cable Termination

Note: Application layouts and dimensions—refer to Pages 5.5-37 to 5.5-43.
Partial Discharge Sensing and Monitoring for Switchgear

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 4000 V and above. Type VC-W switchgear can be equipped with factory-installed partial discharge sensors and partial discharge sensing relay for continuous monitoring of the partial discharges under normal operation. Timely detection of insulation degradation through increasing partial discharges can identify potential problems so that corrective actions can be planned and implemented long before permanent deterioration develops. Partial discharge detection can be the foundation of an effective predictive maintenance program. Trending of partial discharge data over time allows prediction of failures, which can be corrected before catastrophic failure occurs.

The PD sensing and monitoring system is optional. It consists of Eaton’s InsulGard™ Relay and PD sensors specifically developed for application in the switchgear to work with the relay. Partial discharges within the switchgear compartment are detected by installation of a small donut type radio frequency current transformer (RFCT) sensor over floating stress shields of the specially designed bus or line side primary bushings. Partial discharges in customer’s power cables (external discharges) are detected by installation of the RFCT around ground shields of the incoming or outgoing power cables termination.

In 27/38 kV switchgear (refer to Figure 5.3-3), when specified, a set of coupling capacitor sensors is installed in the rear compartment and connected to the primary circuit at every two vertical sections for measurement of discharges internal to the switchgear compartment. The sensor’s output is wired to terminal blocks in control compartment for easy access for periodic field measurements. The sensor can also be connected directly to optional InsulGard relay for continuous monitoring of partial discharges. An additional RFCT sensor for each incoming and outgoing power cable circuits can be provided for measurement of external discharges.

In 5/15 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.
5.3-2 Metal-Clad Switchgear—VacClad-W—Medium-Voltage Partial Discharge

General Description—Partial Discharge Sensing and Monitoring

Figure 5.3-1. InsulGard Relay System

Figure 5.3-2. Typical Partial Discharge Sensor Connections (5–15 kV Switchgear)

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

Radio Frequency Current Sensor (RFCT)

Epoxy Bottles with Stress Shield (5/15 kV Switchgear)

PD Sensors

PD Sensors are Installed in Switchgear Cubicle

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

Pulse Repetition Rate (PPC)

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 management products provide hardware and software solutions that allow customers to interface with their switchgear at varying levels of sophistication. Power Xpert and IQ Meters monitor common electrical parameters and communicate the data via standard industry protocols and optional Web interfaces. Power Xpert Gateways consolidate devices into a single Web browser interface and provide Ethernet connectivity. Eaton’s Power Xpert Insight® and Foresee Web-based software systems display, analyze and store data from multiple devices across the facility to enable management of the customer’s power system.

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
- Integral motorized remote racking (VC-W MR2) for circuit breaker
- Integral motorized remote racking (VC-W MR2) for auxiliary drawer
Integral Motorized Remote Racking Option (VC-W MR2)

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

A microprocessor-based controller card, located below the drive motor, interfaces with an external hand-held pendant (standard), discrete external I/O (optional) or external Modbus communication (optional) and controls the breaker/auxiliary drawer movement via the drive motor. The system is also designed such that it allows manual racking of the breaker/auxiliary using the levering crank accessory if needed. The VC-W MR2 controller interface is shown in Figure 5.3-6. The crank safety switch disables the motor whenever a breaker/auxiliary is being manually racked in or out. The connect, test and disconnect limit switches provide breaker/auxiliary position inputs to the controller card. In addition to the standard permissive switch, two terminals are provided for connection of the customer’s external interlocking/permissive contact(s). Note that a single-phase 120 Vac control supply is required for proper operation of the VC-W MR2 controller and the drive motor.

When VC-W MR2 integral racking is supplied, its controller card is wired to the CAT 6 jack installed in the associated breaker/auxiliary compartment door, and each switchgear lineup is shipped with one hand-held pendant with 30 feet of CAT 6 cable (lengths up to 100 ft available). The pendant interfaces with the MR2 controller card via the CAT 6 cable through a CAT 6 jack located on the breaker/auxiliary compartment door. It allows the operator to move away from the switchgear up to 30 feet. The pendant includes Enable pushbutton for additional security. It must be pressed in order to activate the pendant functions. By pressing Enable pushbutton and an appropriate function pushbutton together momentarily, the operator can rack the breaker between Connected, Test and Disconnected positions or open or close the breaker or rack the auxiliary drawer between Connected and Disconnected positions. Breaker or auxiliary drawer positions (Connect, Test, Disconnect) and breaker opened/closed status are indicated by appropriate LED lights on the pendant. A blinking light indicates that the breaker/auxiliary is in motion through the selected position.
A solid (non-blinking) light indicates that the breaker/auxiliary has reached and stopped in the selected position. In case normal operation fails, the appropriate error code is displayed in a separate two-character LED display window on the pendant. A list of various error codes and their descriptions along with suggested corrective actions are printed on the back side of the pendant. Examples of error states: motor overcurrent, motor overtemperature, motor timed out, breaker position unknown, open permissive, communication error and no breaker/auxiliary.

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

1. I/O interface to allow racking of breaker (connect, test, disconnect) or auxiliary drawer (connect, disconnect) by external hardwired dry contacts and 24 Vdc output for corresponding remote position indicating LEDs.

2. I/O board that provided dry contacts for remote indication of breaker (connect, intermediate, test, disconnect)/auxiliary drawer (connect, test) position within its compartment.

3. I/O interface to allow breaker open/close functions via external hardwired dry contacts and 24 Vdc output for corresponding remote open/close status LEDs.

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

The VC-W MR2 controller is also equipped with terminal blocks to allow the customer to interface with the controller via their SCADA system using a Modbus interface. Please note that only one of the two options, discrete I/O interface or Modbus interface, can be used, but not both. **Figure 5.3-7** shows an illustration of a typical Modbus control example. Additional components shown outside the MR2 controller in **Figure 5.3-7** are not included with the MR2. System-level controls can be optionally supplied by Eaton’s Engineering Services & Systems.

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

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**Technical Data**

**Control Supply Ratings**
- **Nominal control voltage**—120 Vac, 50 or 60 Hz, single-phase
- **Control voltage range**—100 to 140 Vac, 50 or 60 Hz
- **Time to travel from connect to disconnect, or disconnect to connect**—50 seconds maximum
- **Current draw during the travel**—15 A maximum for about 3 seconds and 3.8 A for about 24 seconds
- **Optional dry output contacts when included for position indications are rated for 125 Vac, 2 A**
- **External permissive contacts, when used, must be rated for 24 Vdc, 50 mA**

**Requirements for External Contacts and LEDs when Interfacing with MR2**
- **External contacts should be rated for minimum open circuit voltage of 24 Vdc, and be able to close and carry 5 mA at 24 Vdc**
- **When remote LEDs are used, use 24 Vdc rated LEDs, current up to 20 mA**
- **Optional dry output contacts when included for position indications are rated for 125 Vac, 2 A**
- **External permissive contacts, when used, must be rated for 24 Vdc, 50 mA**

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

Type VC-W MR2 motorized racking accessory has been endurance tested and guaranteed for 500 operations as required by IEEE C37.20.2.
Figure 5.3-6. VC-W MR2 Controller Interface for a VCB with Distinct Test Position and Open/Close Functions
Figure 5.3-7. VC-W MR2 Typical Modbus Control Example
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. Contact Eaton for availability of these circuit breakers
- **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)

<table>
<thead>
<tr>
<th>Identification</th>
<th>Rated Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawout Circuit Breaker Type</td>
<td><strong>Maximum Voltage (V)</strong></td>
</tr>
<tr>
<td></td>
<td>kV</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>50 VCP-W 25</td>
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</tr>
<tr>
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<tr>
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<td>15</td>
</tr>
<tr>
<td>150 VCP-W 50</td>
<td>15</td>
</tr>
<tr>
<td>150 VCP-W 63</td>
<td>15</td>
</tr>
</tbody>
</table>

1 All circuit breakers are tested at 60 Hz; however, they can also be applied at 50 Hz with no derating.
2 4000 A fan-cooled rating is available for 3000 A circuit breakers.
3 Because the voltage range factor \( K = 1 \), the short-time withstand current and the maximum symmetrical interrupting current are equal to the rated symmetrical interrupting current.
4 Based on the standard dc time constant of 45 ms (corresponding to X/R of 17 for 60 Hz) and the minimum contact parting time as determined from the minimum opening time plus the assumed minimum relay time of 1/2 cycle (8.33 ms for 60 Hz).
5 The asymmetrical interrupting current, \( I_{asym} \), is given by \( I_{asym} = I x \sqrt{1 + 2 \times %dc x %dc} \) 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 \( \frac{1.137 x E2}{T2} \).
8 The circuit breakers were tested to the preferred TRV ratings specified in C37.06-2000.

For more information, visit: [www.eaton.com/consultants](http://www.eaton.com/consultants)
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)

<table>
<thead>
<tr>
<th>Identification</th>
<th>Rated Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units</td>
</tr>
<tr>
<td>50 VCP-W 25</td>
<td>1200</td>
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<tr>
<td>50 VCP-W 40</td>
<td>1200</td>
</tr>
<tr>
<td>50 VCP-W 50</td>
<td>1200</td>
</tr>
<tr>
<td>50 VCP-W 63</td>
<td>1200</td>
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<td>150 VCP-W 25</td>
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<td>1200</td>
</tr>
<tr>
<td>150 VCP-W 63</td>
<td>1200</td>
</tr>
</tbody>
</table>

* Each operation consists of one closing plus one opening.
* 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.
### Technical Data—Standard VCP-W Circuit Breakers

#### 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)

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Nominal Voltage Class (kV)</th>
<th>Nominal MVA Class</th>
<th>Voltage (V RMS)</th>
<th>Insulation Level (kV RMS)</th>
<th>Current (kA)</th>
<th>Rated Transient Recovery Voltage (kV RMS)</th>
<th>Rated Maximum Voltage (kV RMS)</th>
<th>Rated Short-Circuit Current (kA RMS)</th>
<th>Rated Reclosing Time (ms)</th>
<th>Rated Permissible Tripping Delay (ms)</th>
<th>Rated Retracting Time (ms)</th>
<th>Current Values Related to Operating Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 VCP-W 250</td>
<td>4.16</td>
<td>250</td>
<td>4.76</td>
<td>1.24</td>
<td>19</td>
<td>300</td>
<td>5</td>
<td>300</td>
<td>5</td>
<td>2</td>
<td>300</td>
<td>3.85, 36, 36, 97, 58, 1.2</td>
</tr>
<tr>
<td>50 VCP-W 250</td>
<td>4.16</td>
<td>250</td>
<td>4.76</td>
<td>1.24</td>
<td>19</td>
<td>300</td>
<td>5</td>
<td>300</td>
<td>5</td>
<td>2</td>
<td>300</td>
<td>3.85, 36, 36, 97, 58, 1.2</td>
</tr>
<tr>
<td>50 VCP-W 350</td>
<td>4.16</td>
<td>350</td>
<td>4.76</td>
<td>1.19</td>
<td>19</td>
<td>300</td>
<td>5</td>
<td>300</td>
<td>5</td>
<td>2</td>
<td>300</td>
<td>4.0, 49, 49, 132, 78, 1.2</td>
</tr>
<tr>
<td>75 VCP-W 500</td>
<td>7.2</td>
<td>500</td>
<td>8.25</td>
<td>1.25</td>
<td>36</td>
<td>300</td>
<td>5</td>
<td>300</td>
<td>5</td>
<td>2</td>
<td>300</td>
<td>6.6, 41, 41, 111, 66, 1.2</td>
</tr>
<tr>
<td>150 VCP-W 500</td>
<td>13.8</td>
<td>500</td>
<td>15</td>
<td>1.30</td>
<td>36</td>
<td>300</td>
<td>5</td>
<td>300</td>
<td>5</td>
<td>2</td>
<td>300</td>
<td>11.5, 23, 23, 62, 37, 1.2</td>
</tr>
<tr>
<td>150 VCP-W 750</td>
<td>13.8</td>
<td>750</td>
<td>15</td>
<td>1.30</td>
<td>36</td>
<td>300</td>
<td>5</td>
<td>300</td>
<td>5</td>
<td>2</td>
<td>300</td>
<td>11.5, 36, 36, 97, 58, 1.2</td>
</tr>
<tr>
<td>150 VCP-W 1000</td>
<td>13.8</td>
<td>1000</td>
<td>15</td>
<td>1.30</td>
<td>36</td>
<td>300</td>
<td>5</td>
<td>300</td>
<td>5</td>
<td>2</td>
<td>300</td>
<td>11.5, 48, 48, 130, 77, 1.2</td>
</tr>
</tbody>
</table>

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. Circuit breakers shown in this table were tested in accordance with IEEE standard C37.09-1979.
4. Contact Eaton for availability of these circuit breakers.
5. For three-phase and line-to-line faults, the symmetrical interrupting capability at an operating voltage
   \[ \frac{I_{sc}}{V_o} = \sqrt[2]{V} \] (Rated Short-Circuit Current)

But not to exceed KJ.

Single line-to-ground fault capability at an operating voltage
   \[ \frac{I_{sc}}{V_o} = 1.15 \sqrt[2]{V} \] (Rated Short-Circuit Current)

But not to exceed KJ.

The above apply on predominately inductive or resistive three-phase circuits with normal-frequency line-to-line recovery voltage equal to the operating voltage.
6. 4000 A forced cooled rating is available for 5/15 kV. 3000 A forced cooled rating is available for 38 kV. Contact Eaton for details.
7. RRRV = 1.137 \frac{V_o}{T_2}

### 3-cycle rating available, refer to Tables 5.4-1A and 5.4-2

### Tripping may be delayed beyond the rated permissible tripping delay at lower values of current in accordance with the following formula:
\[ T (\text{seconds}) = \frac{K \times \text{Rated Short-Circuit Current}^2}{\text{Rated Short-Circuit Current Through Breaker}} \]

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

### 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; 0-0.3s-CO-15s-CO per IEC 58; 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.

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

### Included for reference only.

### Asymmetrical interrupting capability = “S” times symmetrical interrupting capability, both at specified operating voltage.
Table 5.4-2. Available 27/38 kV VCP-W Vacuum Circuit Breaker Types Rated on Symmetrical Current Rating Basis, Per ANSI Standards 1,2,3,4

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Voltage</th>
<th>Insulation Level</th>
<th>Current</th>
<th>Rated Transient Recovery Voltage</th>
<th>Related Required Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kv</td>
<td>kV m/s</td>
<td>kV kA</td>
<td>kV crest v/kA</td>
<td></td>
</tr>
<tr>
<td>27 VCP-W 16</td>
<td>27</td>
<td>750</td>
<td>27</td>
<td>1.0 60 125 1200 2000</td>
<td>16 2 300</td>
</tr>
<tr>
<td>27 VCP-W 22</td>
<td>27</td>
<td>1000</td>
<td>27</td>
<td>1.0 60 125 1200 2000</td>
<td>22 2 300</td>
</tr>
<tr>
<td>27 VCP-W 25</td>
<td>27</td>
<td>1250</td>
<td>27</td>
<td>1.0 60 125 1200 2000</td>
<td>25 5 300</td>
</tr>
<tr>
<td>27 VCP-W 32</td>
<td>27</td>
<td>1600</td>
<td>27</td>
<td>1.0 60 125 1200 2000</td>
<td>31.5 5 300</td>
</tr>
<tr>
<td>27 VCP-W 40</td>
<td>27</td>
<td>2000</td>
<td>27</td>
<td>1.0 60 125 1200 2000</td>
<td>40 5 300</td>
</tr>
<tr>
<td>38 VCP-W 16</td>
<td>38.45</td>
<td>–</td>
<td>38</td>
<td>1.0 80 170 1200 2000</td>
<td>16 2 300</td>
</tr>
<tr>
<td>38 VCP-W 21</td>
<td>38</td>
<td>1.65 80</td>
<td>38</td>
<td>1.65 80 170 1200 2000</td>
<td>21 2 300</td>
</tr>
<tr>
<td>38 VCP-W 25</td>
<td>38</td>
<td>1.0 80</td>
<td>38</td>
<td>1.0 80 170 1200 2000</td>
<td>25 2 300</td>
</tr>
<tr>
<td>38 VCP-W 32</td>
<td>38</td>
<td>0.80</td>
<td>38</td>
<td>0.80 170 1200 2500</td>
<td>31.5 2 300</td>
</tr>
<tr>
<td>38 VCP-W 40</td>
<td>38</td>
<td>0.80</td>
<td>38</td>
<td>0.80 170 1200 2500</td>
<td>40 2 300</td>
</tr>
</tbody>
</table>

1. For capacitor switching, refer to Table 5.4-2.
2. 27 and 38 kV breakers are not UL listed.
3. Circuit breakers shown in this table were tested in accordance with IEEE standard C37.09-1979.
4. For three-phase and line-to-line faults, the symmetrical interrupting capability at an operating voltage

\[ I_{sc} = \frac{V_{p}}{V_{o}} \] (Rated Short-Circuit Current)

But not to exceed KI.

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

\[ I_{sc} = 1.15 \frac{V_{p}}{V_{o}} \] (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.

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

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

\[ T (\text{seconds}) = Y \left( \frac{K_{l k} \times \text{Rated Short-Circuit Current}}{2.7 \times \text{Rated Short-Circuit Current}} \right) \]

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

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-C-O-15s-C-O per IEC 60; and some VCP-Ws have performed O-0.3s-C-O-15s-C-O-15s-C-O-15s-C-O-15s-C-O-15s-C-O-15s-C-O-15s-C-O with no derating. Contact Eaton for special reclosing requirements.

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

Included for reference only.

Asymmetrical interrupting capability = “S” times symmetrical interrupting capability, both at specified operating voltage.

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

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:

- Higher insulation level
- Higher mechanical endurance
- Higher switching life
- Higher close and latch
- Faster rate of recovery voltage
- Higher short-circuit current
- Higher insulation level

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 industry-leading features expected of industry-leading 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
- Definite purpose capacitor switching
- 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

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

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Voltage</th>
<th>Insulation Level</th>
<th>Current Short-Circuit Current</th>
<th>Maximum Permissible Tripping Delay</th>
<th>Rate of Rise of Recovery Voltage (RRV)</th>
<th>Capacitor Switching Ratings</th>
<th>Mechanical Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kV ms</td>
<td>K A ms Total</td>
<td>% Total</td>
<td>kA rms Peak</td>
<td>kA rms Peak</td>
<td>ms</td>
<td>Seconds</td>
</tr>
<tr>
<td>50 VCP-W 25C</td>
<td>5.96</td>
<td>1 24 75</td>
<td>25</td>
<td>50 31 75 75</td>
<td>97</td>
<td>25 50</td>
<td>2.0 0.9</td>
</tr>
<tr>
<td>50 VCP-W 40C</td>
<td>5.96</td>
<td>1 24 75</td>
<td>40</td>
<td>75 58 139 40</td>
<td>20 0.9</td>
<td>0.9 9.8</td>
<td>630 1000 250</td>
</tr>
<tr>
<td>50 VCP-W 60C</td>
<td>5.96</td>
<td>1 24 75</td>
<td>50</td>
<td>67 64 64 62</td>
<td>139 50 20 2.0</td>
<td>0.9 0.9 0.8</td>
<td>630 1000 250</td>
</tr>
<tr>
<td>50 VCP-W 63C</td>
<td>5.96</td>
<td>1 24 75</td>
<td>63</td>
<td>62 83 175 63</td>
<td>50 20 2.0</td>
<td>1.1</td>
<td>250</td>
</tr>
<tr>
<td>75 VCP-W 50C</td>
<td>10.3</td>
<td>1 42 95</td>
<td>50</td>
<td>67 64 64 62</td>
<td>139 50 20 2.0</td>
<td>0.9 0.9 0.8</td>
<td>630 1000 250</td>
</tr>
<tr>
<td>150 VCP-W 25C</td>
<td>17.5</td>
<td>1 42 95</td>
<td>25</td>
<td>50 31 75 75</td>
<td>97 25 50</td>
<td>2.0 0.9</td>
<td>0.9 1000 250</td>
</tr>
<tr>
<td>150 VCP-W 40C</td>
<td>17.5</td>
<td>1 42 95</td>
<td>40</td>
<td>75 58 139 40</td>
<td>20 0.9</td>
<td>0.9 0.9 0.8</td>
<td>630 1000 250</td>
</tr>
<tr>
<td>150 VCP-W 60C</td>
<td>17.5</td>
<td>1 42 95</td>
<td>50</td>
<td>67 64 64 62</td>
<td>139 50 20 2.0</td>
<td>0.9 0.9 0.8</td>
<td>630 1000 250</td>
</tr>
<tr>
<td>150 VCP-W 63C</td>
<td>17.5</td>
<td>1 42 95</td>
<td>63</td>
<td>62 83 175 63</td>
<td>50 20 2.0</td>
<td>1.1</td>
<td>250</td>
</tr>
</tbody>
</table>

Note: Refer to Page 5.4-7 for footnotes.
### Table 5.4-2. VCP-WC Ratings (Symmetrical Current Basis), Rated K = 1 (Continued)

<table>
<thead>
<tr>
<th>Identification</th>
<th>Rated Values</th>
<th>Insulation Level</th>
<th>Current</th>
<th>Mechanical Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Voltage</td>
<td>kV</td>
<td>Current</td>
<td>Insulation</td>
</tr>
<tr>
<td>270 VCP-W 25C</td>
<td>27 1 60 125</td>
<td>1200 1600</td>
<td>25 75 36 85</td>
<td>25</td>
</tr>
<tr>
<td>270 VCP-W 32C</td>
<td>27 1 60 125</td>
<td>1200 1600</td>
<td>31.5 55 40 100</td>
<td>31.5</td>
</tr>
<tr>
<td>270 VCP-W 40C</td>
<td>27 1 60 125</td>
<td>1200 1600</td>
<td>40 50 49 112</td>
<td>40</td>
</tr>
<tr>
<td>380 VCP-W 16C</td>
<td>38 1 80 170</td>
<td>1200 2000</td>
<td>16 75 23.3</td>
<td>16</td>
</tr>
<tr>
<td>380 VCP-W 25C</td>
<td>38 1 80 170</td>
<td>1200 2000</td>
<td>25 65 34.0</td>
<td>25</td>
</tr>
<tr>
<td>380 VCP-W 32C</td>
<td>38 1 80 170</td>
<td>1200 2000</td>
<td>33.1 57 42.5</td>
<td>31.5</td>
</tr>
<tr>
<td>380 VCP-W 40C</td>
<td>38 1 80 170</td>
<td>1200 2000</td>
<td>40 63 53.5</td>
<td>107</td>
</tr>
</tbody>
</table>

1. Except as noted.
2. 3 cycles.
3. Contact Eaton for higher RRRV or for more information.
4. 4000 A FC rating available.
5. C37.04.a-2003 Class C2 at 15 kV.
6. Close and Latch Current for 1200A Type 150 VCP-W 25C is proven at 15 kV. For sealed interrupters at high altitudes, switching voltage is not derated.
7. Capacitor Switching Ratings are proven at 15 kV. For sealed interrupters at high altitudes, switching voltage is not derated.
8. 2.5 seconds.
9. 1.6 second.
10. 1 second.
11. 2000 A FC to 3000 A.
12. 2500 A FC to 3000 A.
13. Tested at 27 kV, 350 A isolated or back-to-back capacitor bank, inrush current 4.6 kA, inrush frequency 1.2 kHz.

**Note:** 38 kV, 2500 A and 3000 A WC breakers are not rated for rapid reclosing.
Type VCP-WG Generator Circuit Breakers

The VCP-WG (drawout) and VCP-WRG (fixed) circuit breakers meet, and even exceed, the rigorous service duty requirements for generator circuit applications as defined by IEEE. Eaton’s VCP-WG and VCP-WRG generator breakers are available in two frame sizes. The 29.00-inch frame (29.00 inches wide with front cover on) has ratings up to 15 kV, 63 kA and 3000 A (4000 A with forced-air cooling). The 31.00-inch frame (31.00 inches wide with front cover on) has ratings up to 15 kV, 75 kA and 4000 A (5000 A with forced-air cooling). The 31.00-inch frame is also available in a fixed version with ratings up to 15 kV, 75 kA and 6000 A (7000 A with forced-air cooling).

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.

High Continuous Current Levels

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

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

Unique Fault Current Conditions

System-source (aka, transformer-fed) faults (see Figure 5.4-1, 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. For more information, visit: www.eaton.com/consultants
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)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>Short-Circuit Current (Isc)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>50 kA</td>
</tr>
<tr>
<td><strong>Maximum Voltage (V): 5 kV</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame in inches (mm) (see Figure 5.4.3 on Page 5.4-9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratings Assigned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Current A rms</td>
<td></td>
<td>4000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1200</td>
</tr>
<tr>
<td>Dielectric Strength</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power frequency withstand voltage kV rms</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Lightning impulse withstand voltage kV peak</td>
<td></td>
<td>6300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7000</td>
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<tr>
<td>Intermittent Time ms</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>83</td>
</tr>
<tr>
<td>Closing Time ms</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>Short-Circuit Current</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Asymmetrical current interrupting capability kA rms % dc</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>Ref: Minimum opening time ms</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Short-time current carrying capability kA rms</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Duration of short-time current sec</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Closing and Latching Capability kV peak</td>
<td></td>
<td>137</td>
</tr>
<tr>
<td>First Generator-Source Symmetrical Current Interrupting Capability kA rms</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>First Generator-Source Asymmetrical Current Interrupting Capability % dc</td>
<td></td>
<td>130</td>
</tr>
<tr>
<td>Second Generator-Source Symmetrical Current Interrupting Capability kA rms</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Second Generator-Source Asymmetrical Current Interrupting Capability % dc</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Prospective TRV—Rate of Rise of Recovery Voltage (RRRV) kV / μs</td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>Transient recovery voltage—Peak (E2 = 1.84 x V) kV / μs</td>
<td></td>
<td>9.2</td>
</tr>
<tr>
<td>Transient recovery voltage—Time to Peak (T2 = 0.62 x V) μs</td>
<td></td>
<td>3.1</td>
</tr>
<tr>
<td>Load Current Switching Endurance Capability Operations</td>
<td></td>
<td>10,000</td>
</tr>
<tr>
<td>No-Load Mechanical Endurance Capability Operations</td>
<td></td>
<td>10,000</td>
</tr>
<tr>
<td>Out-of-Phase Current Switching Capability kA</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>90° out-of-phase power frequency recovery voltage (= 1.5 x sqrt(2/3) x V) kV</td>
<td></td>
<td>6.1</td>
</tr>
<tr>
<td>90° out-of-phase inherent TRV—Rate of Rise of Recovery Voltage (RRRV) kV / μs</td>
<td></td>
<td>3.3</td>
</tr>
<tr>
<td>Transient recovery voltage—Time to Peak (T2 = 0.89 x V) μs</td>
<td></td>
<td>4.5</td>
</tr>
</tbody>
</table>

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.
- Standard operating duty: CO - 30 m - CO.
- Test certificates available.

For more information, visit: www.eaton.com/consultants
## 15 kV Class Generator Circuit Breaker Ratings

### Table 5.4-4. Generator Circuit Breaker Types: VCP-WG (Drawout—DO) / VCP-WRG (Fixed—FIX) (Continued)

<table>
<thead>
<tr>
<th>Description</th>
<th>Units</th>
<th>50 kA</th>
<th>63 kA</th>
<th>75 kA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum Voltage (V): 15 kV</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame in inches (mm) (see Figure 5.4-3 on Page 5.4-9)</td>
<td>—</td>
<td>29.00</td>
<td>29.00</td>
<td>31.00</td>
</tr>
<tr>
<td><strong>Ratings Assigned</strong></td>
<td></td>
<td>31.00</td>
<td>31.00</td>
<td>31.00</td>
</tr>
<tr>
<td>Continuous Current</td>
<td>A rms</td>
<td>29.00</td>
<td>29.00</td>
<td>31.00</td>
</tr>
<tr>
<td>Prospective TRV—Rate of Rise of Recovery Voltage</td>
<td>kV / µs</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Current Interrupting Capability</td>
<td>kA rms</td>
<td>27.6</td>
<td>27.6</td>
<td>27.6</td>
</tr>
<tr>
<td>Duration of short-time current</td>
<td>s</td>
<td>9.3</td>
<td>9.3</td>
<td>9.3</td>
</tr>
<tr>
<td><strong>Power frequency withstand voltage</strong></td>
<td>kV rms</td>
<td>36</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td><strong>Lightning impulse withstand voltage</strong></td>
<td>kV peak</td>
<td>95</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Closing Time</td>
<td>ms</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>Closing and Latching Capability</strong></td>
<td>kA peak</td>
<td>137</td>
<td>137</td>
<td>137</td>
</tr>
<tr>
<td>First Generator-Source Symmetrical Current Interrupting Capability</td>
<td>kA rms</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Second Generator-Source Asymmetrical Current Interrupting Capability</td>
<td>% dc</td>
<td>130</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>First Generator-Source Symmetrical Current Interrupting Capability</td>
<td>% dc</td>
<td>130</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>Second Generator-Source Symmetrical Current Interrupting Capability</td>
<td>% dc</td>
<td>130</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>Prospective TRV—Rate of Rise of Recovery Voltage (RRRV)</td>
<td>kV / µs</td>
<td>27.6</td>
<td>27.6</td>
<td>27.6</td>
</tr>
<tr>
<td>Load Current Switching Endurance Capacity</td>
<td>Operations</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>No-Load Mechanical Endurance Capacity</td>
<td>Operations</td>
<td>10,000</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Out-of-Phase Current Switching Capability</td>
<td>kA</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>90° out-of-phase power frequency recovery voltage (E2 = 1.84 x V)</td>
<td>kV rms</td>
<td>18.4</td>
<td>18.4</td>
<td>18.4</td>
</tr>
<tr>
<td>90° out-of-phase inherent TRV—Rate of Recovery Voltage (RRRV)</td>
<td>kV / µs</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Transient recovery voltage—Time to Peak</td>
<td>µs</td>
<td>13.4</td>
<td>13.4</td>
<td>13.4</td>
</tr>
</tbody>
</table>

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: 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

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Breaker Rating</th>
<th>Closing Time Milliseconds</th>
<th>Opening Time Milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 V, 125 V, 250 Vdc</td>
<td>All</td>
<td>45–60</td>
<td>30–45</td>
</tr>
<tr>
<td>120 V, 240 Vac</td>
<td>All</td>
<td>45–60</td>
<td>—</td>
</tr>
<tr>
<td>120 V or 240 Vac capacitor trip</td>
<td>All</td>
<td>—</td>
<td>26–41</td>
</tr>
<tr>
<td>Optional—undervoltage trip release 48 V, 125 V, 250 Vdc</td>
<td>All</td>
<td>—</td>
<td>30–45</td>
</tr>
</tbody>
</table>

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 — Fast Sequential Transfer

3 Times shown are based on 60 Hz.
Usual Service Conditions
Usual service conditions for operation of metal-clad switchgear are as follows:

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

Applications Above 3300 Feet (1006 m)
Equipment utilizing sealed interrupting devices (such as vacuum interrupters) does not require derating of rated maximum voltage. The rated one-minute power frequency withstand voltage, the impulse withstand voltage and the continuous current rating must be multiplied by the appropriate correction factor in Table 5.4-8 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

<table>
<thead>
<tr>
<th>Interrupting Current</th>
<th>50 Hz</th>
<th>25 Hz</th>
<th>16 Hz</th>
<th>12 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>4000 (1219)</td>
<td>0.98</td>
<td>0.95</td>
<td>0.92</td>
<td>0.91</td>
</tr>
<tr>
<td>5000 (1524)</td>
<td>0.89</td>
<td>0.86</td>
<td>0.83</td>
<td>0.96</td>
</tr>
<tr>
<td>6000 (1829)</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>6600 (2012)</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>7000 (2137)</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>8000 (2438)</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Rated Short-Time and Close and Latch Currents
No derating is required for short time and close and latch current at lower frequency.

Rated Continuous Current
Because the effective resistance of circuit conductors is less at lower frequency, continuous current through the circuit can be increased somewhat. Table 5.4-7 provides nominal current rating for VCP-W breakers when operated at frequencies below 60 Hz.

Table 5.4-7. Current Ratings

<table>
<thead>
<tr>
<th>Rated Continuous Current at 60 Hz</th>
<th>Nominal Current at Frequency Below 60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50 Hz</td>
</tr>
<tr>
<td>1200 A</td>
<td>1243</td>
</tr>
<tr>
<td>2000 A</td>
<td>2075</td>
</tr>
<tr>
<td>3000 A</td>
<td>3119</td>
</tr>
</tbody>
</table>

Power Frequency and Impulse Withstand Voltage Ratings
No derating is required for lower frequency.

CTs, VTs, Relays and Instruments
Application at frequency other than rated frequency must be verified for each device on an individual basis.

Table 5.4-8. Altitude Derating Factors

<table>
<thead>
<tr>
<th>Altitude Above Sea Level in Feet (m)</th>
<th>Altitude Correction Factor to be Applied to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>Rated Continuous Current</td>
</tr>
<tr>
<td>3300 (1006) (and Below)</td>
<td>1.0</td>
</tr>
<tr>
<td>4000 (1219)</td>
<td>0.98</td>
</tr>
<tr>
<td>5000 (1524)</td>
<td>0.95</td>
</tr>
<tr>
<td>6000 (1829)</td>
<td>0.92</td>
</tr>
<tr>
<td>6600 (2012)</td>
<td>0.91</td>
</tr>
<tr>
<td>7000 (2137)</td>
<td>0.89</td>
</tr>
<tr>
<td>8000 (2438)</td>
<td>0.86</td>
</tr>
<tr>
<td>9000 (2743)</td>
<td>0.83</td>
</tr>
<tr>
<td>10,000 (3048)</td>
<td>0.80</td>
</tr>
<tr>
<td>12,000 (3688)</td>
<td>0.75</td>
</tr>
<tr>
<td>13,200 (4023)</td>
<td>0.72</td>
</tr>
<tr>
<td>14,000 (4267)</td>
<td>0.70</td>
</tr>
<tr>
<td>16,000 (4877)</td>
<td>0.65</td>
</tr>
<tr>
<td>16,400 (5000)</td>
<td>0.64</td>
</tr>
<tr>
<td>18,000 (5486)</td>
<td>0.61</td>
</tr>
<tr>
<td>20,000 (6096)</td>
<td>0.56</td>
</tr>
</tbody>
</table>
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 5.4-9 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.

Switchgear Heat Loss
The heat-loss data for circuit breakers given in Table 5.4-10 includes portion of main bus conductors and load runbacks. Please note that the estimated wattage given for each component is at its full rating. For example, the chart shows 600 W for 1200 A, 5 kV VCP-W breaker. It simply means that we estimated 600 W loss in breaker in a 1200 A, 5 kV compartment when the circuit breaker is carrying full 1200 A. The actual loss, of course, will depend on the actual current being carried by the breaker. If the full load current of the load connected to that 1200 A breaker, for example, is only 200 A, the heat-loss in that compartment will be much less. By simple “I x I x R” calculations, one can easily calculate actual loss at 200 A as = 600 x (200/1200) x (200/1200) = 16.67 W. Also, in case of lineup consisting of many feeders, all feeders might not be carrying or supplying loads at all times. If that is the case, then one can further reduce total watt loss for the lineup by applying a utilization factor.

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>
<thead>
<tr>
<th>Type of Switchgear Assembly</th>
<th>Breaker Rating</th>
<th>1200 A</th>
<th>2000 A</th>
<th>2500 A</th>
<th>3000 A</th>
<th>4000 A Fan Cooled</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCP-W</td>
<td>5, 15, and 27 kV</td>
<td>600 W</td>
<td>1400 W</td>
<td>—</td>
<td>2100 W</td>
<td>3700 W —</td>
</tr>
<tr>
<td>VCP-W</td>
<td>38 kV</td>
<td>850 W</td>
<td>1700 W</td>
<td>2300 W</td>
<td>3800 W</td>
<td>—</td>
</tr>
</tbody>
</table>

Other Components

<table>
<thead>
<tr>
<th>Type</th>
<th>Breaker Rating</th>
<th>60 W</th>
<th>100 W</th>
<th>80 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each CT, standard accuracy</td>
<td>50 W</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each CT, high accuracy Each VT</td>
<td>100 W</td>
<td>100 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPT single-phase, 25 kVA CPT single-phase, 45 kVA</td>
<td>460 W</td>
<td>892 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space heater—each</td>
<td>250 W</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 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 5.4-11. Standard VCP-W (Non-Arc-Resistant) Metal-Clad Switchgear Ratings Per IEEE C37.20.2-2015

<table>
<thead>
<tr>
<th>Rated Maximum Voltage</th>
<th>(Ref.) Rated Voltage Range</th>
<th>Insulation Level</th>
<th>Rated Main Bus Continuous Current</th>
<th>Rated Short-Time Short-Circuit Current Withstand (2-Second)</th>
<th>Rated Momentary Short-Circuit Current Withstand (10-Cycle) (167 ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td></td>
<td>Power Frequency Withstand Voltage, 60 Hz, 1 Minute</td>
<td>Lightning Impulse Withstand Voltage [LIWV] (BIL)</td>
<td>K*I</td>
</tr>
<tr>
<td></td>
<td>kV rms</td>
<td>kA rms</td>
<td>kV rms</td>
<td>kV Peak</td>
<td>Amperes</td>
</tr>
<tr>
<td>4.76</td>
<td>1</td>
<td>25</td>
<td>19</td>
<td>60</td>
<td>1200, 2000, 3000, 4000</td>
</tr>
<tr>
<td></td>
<td>1.24</td>
<td>29</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>40</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>1.19</td>
<td>41</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>50</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>1.1</td>
<td>63</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>63</td>
</tr>
<tr>
<td>8.25</td>
<td>1.25</td>
<td>33</td>
<td>36</td>
<td>95</td>
<td>1200, 2000, 3000, 4000</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>50</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>50</td>
</tr>
<tr>
<td>15</td>
<td>1.3</td>
<td>18</td>
<td>36</td>
<td>95</td>
<td>1200, 2000, 3000, 4000</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>25</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>29</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>40</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>1.1</td>
<td>37</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>50</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>1.1</td>
<td>63</td>
<td></td>
<td>1200, 2000, 3000, 4000</td>
<td>63</td>
</tr>
<tr>
<td>27</td>
<td>1</td>
<td>16</td>
<td>60</td>
<td>125</td>
<td>1200, 2000, 2500, 2700</td>
</tr>
<tr>
<td></td>
<td>1.3</td>
<td>22</td>
<td></td>
<td>1200, 2000, 2500, 2700</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>25</td>
<td></td>
<td>1200, 2000, 2500, 2700</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>31.5</td>
<td></td>
<td>1200, 2000, 2500, 2700</td>
<td>31.5</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>40</td>
<td></td>
<td>1200, 2000, 2500, 2700</td>
<td>40</td>
</tr>
<tr>
<td>38</td>
<td>1</td>
<td>16</td>
<td>80</td>
<td>150</td>
<td>1200, 2000, 2500</td>
</tr>
<tr>
<td></td>
<td>1.6</td>
<td>25</td>
<td></td>
<td>1200, 2000, 2500</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>31.5</td>
<td></td>
<td>1200, 2000, 2500</td>
<td>31.5</td>
</tr>
<tr>
<td></td>
<td>1.65</td>
<td>23</td>
<td></td>
<td>1200, 2000, 2500</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>40</td>
<td></td>
<td>1200, 2000, 2500</td>
<td>40</td>
</tr>
</tbody>
</table>

1. The switchgear assembly is designed for use with type VCP-W, VCP-VC and VCP-WG circuit breakers. However, please note that certain VCP-VC 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 4000 A at 4.76, 8.25 and 15 kV, and 3000 A at 38 kV.

4. 27 kV 2500 A and 3000 A 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 C37.20.2-2015.

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

8. This is a standard IEEE C37.20.2 rating for 38 kV Class of switchgear.
### 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 5.4-12. VacClad-W Arc-Resistant Metal-Clad Switchgear

<table>
<thead>
<tr>
<th>Rated Maximum Voltage</th>
<th>(Ref.) Rated Voltage Range Factor K</th>
<th>[Ref.] Rated Short-Circuit Current I</th>
<th>Ratings per IEEE C37.20.2-2015</th>
<th>Enclosure Internal Arc Withstand</th>
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</thead>
<tbody>
<tr>
<td>kV</td>
<td>kA rms</td>
<td>kV rms</td>
<td>kV Peak</td>
<td>Amperes</td>
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<td>4.76</td>
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<td>97</td>
<td>58</td>
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<td>49</td>
<td>132</td>
<td>78</td>
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<tr>
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<td>1200, 2000, 3000, 4000</td>
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<td>40</td>
</tr>
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<td>1200, 2000, 2500, 3000</td>
<td>31.5</td>
<td>85</td>
<td>51</td>
</tr>
<tr>
<td>1.0</td>
<td>1200, 2000, 2500, 3000</td>
<td>40</td>
<td>108</td>
<td>64</td>
</tr>
</tbody>
</table>

1. The switchgear assembly is designed for use with type VCP-W, VCP-WC and VCP-WG circuit breakers. However, please note that certain VCP-WC circuit breakers may have higher capabilities than required by ANSI standards. In such cases, switchgear assembly ratings as given in this table will apply.
2. Switchgear assemblies can be supplied with UL/CSA label. Contact Eaton for availability.
3. 5–15 kV switchgear is supplied with a plenum. 27–38 kV switchgear is supplied with arc wall. For plenum requirements at 27 and 38 kV, contact Eaton.
4. Maximum continuous current rating for circuit breaker that can be supplied at 38 kV is 2500 A.
5. Please note that use of certain current transformers (for example, bar type CTs) and protective devices may limit the duration to a value less than 2 seconds.
6. These values exceed 2.6*I*I required by IEEE C37.20.2-2015.
7. These values exceed 1.5*I*I required by IEEE C37.20.2-2015.
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
- IEEE C57.142
  - Guide to Describe the Occurrence and Mitigation of Switching Transients Induced by Transformers, Switching Device, and System Interaction

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. In all cases described below, Eaton highly recommends performing a switching transient study to determine the transient response, and properly select and rate the transient mitigation equipment.

Surge Protection Recommendations

Note: The complete surge protection for power system equipment consists of a surge arrester in parallel with an RC snubber. Eaton can custom design and supply an RC snubber to the specific characteristics of the system of interest, and highly recommends this approach. The abbreviation RC snubber used in the text below refers to Eaton’s custom device. Alternatively, standard, one-size-fits-all devices are available from other manufacturers. The abbreviation Protec Z used in the text below refers to Surge Protection Device manufactured by NTSA. An equivalent device offered by other manufacturers, such as Type EH2 by ABB, 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 Protec Z. 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 Protec Z for transformers connected by cables with lengths up to 200 feet, depending on the size of cable and number of conductors per phase. The surge protection device should be located and connected at the transformer terminals. In general, no surge protection is needed for transformers with basic impulse level (BIL) withstand ratings equal to that of the switchgear and connected to the switchgear by cables at least 200 feet or longer. For transformers with lower BIL than the switchgear, provide surge arrester in parallel with RC snubber or Protec Z.
   c. Shunt Reactor Switching—Provide surge arrester in parallel with RC snubber or Protec Z at the reactor terminals.
   d. Capacitor Switching—Provide surge arresters at the line-side of the capacitor bank. Make sure that the capacitor’s BIL withstand rating is equal to that of the switchgear. In the case of harmonic filter banks, install additional surge arresters on the line reactors. Further, for multi-step capacitor banks or capacitor banks in close proximity, back-to-back switching transient effects can be minimized with the application of inrush limiting reactors.
   e. Shunt Reactor Switching—Provide surge arrester in parallel with RC snubber or Protec Z at the reactor terminals.
7b. Series Current Limiting Reactor Switching—Provide surge arrester in parallel with RC snubber, or Protec Z at both reactor terminals. Alternatively, the RC snubber can be installed in parallel with the series current limiting reactor.

8. Motor Starting Reactors or Reduced Voltage Auto-Transformers (RVAT)—Provide surge arrester in parallel with RC snubber, or Protec Z at the reactor tap in use and/or RVAT terminals and/or motor terminals.


10. Voltage Transformers (VTs) and Control Power Transformers (CPTs)—In certain power system configurations, VTs and CPTs installed inside the switchgear are susceptible to: a) voltage transients induced by opening and closing of upstream switching device, b) low frequency (less than power frequency of 50/60 Hz) ferro-resonance when de-energizing a long run of power cables connected to those transformers, c) classical ferro-resonance due to single-phase switching or energization of certain VT configurations, and d) internal resonance where the natural frequency of the primary windings can under some circumstances be excited to resonate by the switching frequency. Eaton does not provide surge protection for VTs and CPTs as standard. Eaton recommends performing a power system switching transient study to determine need for surge protection (surge arrester, RC snubber, damping resistor, other solution) for given power system components.

Switching Transients Study
Eaton's Power System Engineering group can perform the switching transient study using the Electromagnetic Transients Program (EMTP) to determine the transient response, and properly select and rate the transient mitigation equipment.

The switching transient study can simulate in EMTP the various transient concerns described above including primary switching of transformers, arc-furnace transformer switching, motor and generator switching, generator breaker transient recovery voltage (TRV) evaluation, capacitor isolated switching and back-to-back switching, switching of shunt reactors and series current limiting reactors as well as transients associated with RVAT contactor switching. VTs and CPTs require a special focus of transient studies involving EMTP simulation of switching, ferro-resonance and internal resonance.

Through the EMTP study, the surge capacitor and resistor components of the RC snubber are precisely selected for each application, to match the electrical system surge impedance and to provide superior transient suppression. The EMTP study also provides the recommendation for the best location of the snubber assembly to protect the transformer, generator or motor. When appropriate for all systems under study, but especially in the case of VTs and CPTs, the EMTP study will recommend additional forms of surge protection, mitigation techniques and/or alternative equipment ratings and configurations.

Contact Eaton if switching transients study is desired.
Types of Surge Protection Devices

A. Solidly Grounded Systems:
   Arrester MCOV rating should be equal to 1.05 x VLL/(1.732 x T), where VLL is nominal line-to-line service voltage, and T is derating factor to allow for operation at +5% voltage variation above the nominal voltage. Under normal operating conditions, the capacitor offers very low impedance, thus effectively “isolating” the resistor R and 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 resistor, set to trigger at 1 to 2 PU voltage, where 1 PU = 1.414*(VLL/1.732). The surge capacitor is typically sized to be 0.15 to 0.25 microfarad. As with RC snubber, under normal operating conditions, the capacitor offers very low impedance, thus 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 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 RC snubber provides protection against high frequency transients by absorbing, damping and the transients. Please note RC snubber alone may not provide adequate protection. To limit peak magnitude of the transient, application of surge arrester should also be considered.

B. Low Resistant Grounded Systems
   (systems grounded through resistor rated for 10 seconds):
   Arrester 10-second MCOV capability at 60 ºC, which is obtained from manufacturer’s data, should be equal to 1.05 x VLL, where VLL 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 VLL/T, where VLL and T are as defined above.

Refer to Table 5.4-13 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 over-voltage, 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
An 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 network, 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, damping, and the transients. Please note RC snubber alone may not provide adequate protection. To limit peak magnitude of the transient, application of surge arrester should also be considered.

Protec Z
A Protec Z 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 resistor, set to trigger at 1 to 2 PU voltage, where 1 PU = 1.412*(VLL/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 “isolating” 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 Protec Z 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 Protec Z 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 Protec Z.
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 Protec Z, 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 Protec Z, to mitigate possible virtual current chopping.

Better protection: RC snubber or Protec Z in parallel with surge arrester for protection from high frequency transients and voltage peaks.

Best protection: For optimum or best protection, a switching transient analysis is recommended, and surge protection needs as determined based on such study should be implemented.

### Table 5.4-13. Surge Arrester Selections—Recommended Ratings

<table>
<thead>
<tr>
<th>Service Voltage Line-to-Line kV</th>
<th>Distribution Class Arresters</th>
<th>Station Class Arresters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solidly Grounded System</td>
<td>Low Resistance Grounded System</td>
</tr>
<tr>
<td></td>
<td>Nominal</td>
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<tr>
<td>38.00</td>
<td>30</td>
<td>24.40</td>
</tr>
</tbody>
</table>
Instrument Transformers

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

Voltage Transformers

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

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

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

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

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

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

Current Transformers

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

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

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

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

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

Standard accuracy current transformers are normally more than adequate for most standard applications of microprocessor-based protective relays and meters. See Table 5.4-16 for CT accuracy information.

<table>
<thead>
<tr>
<th>Rating-Volts</th>
<th>2400</th>
<th>4200</th>
<th>4800</th>
<th>7200</th>
<th>8400</th>
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<th>14400</th>
<th>15600</th>
<th>18000</th>
<th>21000</th>
<th>24000</th>
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<td>150-1</td>
<td>175-1</td>
<td>200-1</td>
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<td>300-1</td>
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</table>
### Table 5.4-15. Standard Voltage Transformer, 60 Hz Accuracy Information

<table>
<thead>
<tr>
<th>Switchgear Voltage Transformer ANSI Accuracy</th>
<th>kV</th>
<th>Maximum Number Per Set and Connection</th>
<th>Standard Ratios</th>
<th>Burdens at 120 Volts</th>
<th>Burdens at 69.3 Volts</th>
<th>Thermal Rating 55°C Connection</th>
<th>Volt-Ampere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>W, X, Y Z M ZZ</td>
<td>W, X Y M Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 BIL</td>
<td>60</td>
<td>2LL or 3LG</td>
<td>20, 35, 40</td>
<td>0.3 1.2 --</td>
<td>-- --</td>
<td>LL LG LG</td>
<td>700 400 700</td>
</tr>
<tr>
<td>75 BIL</td>
<td>95</td>
<td>2LL or 3LG</td>
<td>35, 40, 60, 70, 100, 120</td>
<td>0.3 0.3 0.6</td>
<td>0.3 0.3 0.3 1.2</td>
<td>LL LG LG</td>
<td>1000 550 1000</td>
</tr>
<tr>
<td>27</td>
<td>125</td>
<td>2LL or 3LG</td>
<td>90, 100, 120, 130, 150, 175, 200, 225</td>
<td>0.3 0.3 1.2</td>
<td>0.3 0.3 0.3 1.2</td>
<td>LL LG LG</td>
<td>1000 550 1000</td>
</tr>
<tr>
<td>38</td>
<td>170</td>
<td>2LL or 3LG</td>
<td>175, 300</td>
<td>0.3 0.3 0.3 0.3</td>
<td>0.3 0.3 0.3 0.3</td>
<td>LL LG LG</td>
<td>1000 550 1000</td>
</tr>
</tbody>
</table>

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

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

### Table 5.4-16. Current Transformers, 55°C Ambient

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

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.
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 5.4-25 and 5.4-26.

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 5.4-17.

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 5.4-17. Where higher interrupting capacities are required, an interposing contactor should be specified.

### Table 5.4-17. Auxiliary Switch Contacts Interrupting Capacities

<table>
<thead>
<tr>
<th>Type of Auxiliary Switch</th>
<th>Continuous Current Interrupting Capacity in Amperes</th>
<th>Control Circuit Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120 Vac</td>
<td>240 Vac</td>
</tr>
<tr>
<td>Non-inductive Interrupting Capacity in Amperes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaker Auxiliary Switch</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>TOC Switch</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>MOC Switch</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Inductive Interrupting Capacity in Amperes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breaker Auxiliary Switch</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>TOC Switch</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>MOC Switch</td>
<td>20</td>
<td>15</td>
</tr>
</tbody>
</table>
### Table 5.4-18. VCP-W Breaker Stored Energy Mechanism Control Power Requirements

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Spring Charging Motor</th>
<th>Close or Trip Ampereas</th>
<th>UV Trip mA Maximum</th>
<th>Voltage Range</th>
<th>Indicating Light Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inrush Amperes</td>
<td>Run Amperes</td>
<td>Average Run Time, Sec.</td>
<td></td>
<td>Close</td>
</tr>
<tr>
<td>48 Vdc</td>
<td>16.0</td>
<td>2</td>
<td>6</td>
<td>200</td>
<td>36–56</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>16.0</td>
<td>4</td>
<td>6</td>
<td>80</td>
<td>100–140</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>16.0</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>200–280</td>
</tr>
<tr>
<td>120 Vac</td>
<td>9.2</td>
<td>2</td>
<td>6</td>
<td>—</td>
<td>104–127</td>
</tr>
<tr>
<td>240 Vac</td>
<td>9.2</td>
<td>2</td>
<td>6</td>
<td>—</td>
<td>208–254</td>
</tr>
</tbody>
</table>

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

### Table 5.4-19. Control Power Transformers—Single-Phase, 60 Hz

<table>
<thead>
<tr>
<th>Rated Primary Voltage, Volt</th>
<th>Rated Secondary Voltage, Volt</th>
<th>kVA</th>
<th>kV Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>2400</td>
<td>240–120</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4160</td>
<td>240–120</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4800</td>
<td>240–120</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>7200</td>
<td>240–120</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>8400</td>
<td>240–120</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>12470</td>
<td>240–120</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>13200</td>
<td>240–120</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>13800</td>
<td>240–120</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>23000</td>
<td>240–120</td>
<td>27</td>
<td>15</td>
</tr>
<tr>
<td>34500</td>
<td>240–120</td>
<td>38</td>
<td>38</td>
</tr>
</tbody>
</table>
Figure 5.4-8. Typical 5/15/27 kV VCP-W “dc” and “ac” Control Schematics

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

Operation:  
- **LS1** = Closed until springs are fully charged.  
- **bb** = Open until springs are fully charged.  
- **LS2** = Closed until springs are fully charged.  
- **aa** = Open 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** = Breaker Control Switch—Close
- **C** = Breaker Control Switch—Trip
- **T** = Anti Pump Relay
- **Y** = Spring Charged Indicating Light
- **SR** = Anti Pump Relay (Coil)
- **M** = Spring Charge Motor
- **ST** = Shunt Trip
- **PR** = Protective Relay
- **A** = Secondary Disconnect

Operation:

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

Customer Must Furnish This “a” Contact from Auxiliary Switch When Second Trip Coil Option is Chosen and Make the Appropriate Connections.
Figure 5.4-10. Protective Relays—Feeder Circuit

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

Figure 5.4-12. Protective Relays—Transformer Feeder

Figure 5.4-13. Protective Relays—Induction Motors Above 1500 hp and Synchronous Motors
**Figure 5.4-14. 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 5.4-15–5.4-17 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, 1200 A circuit breakers.

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

---

**Figure 5.4-15. Typical Main-Tie-Main Arrangement with Bus and Line VTs and Line CPTs**

5 or 15 kV VCP-W Switchgear, 1200 or 2000 A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures

---

**Figure 5.4-16. 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 2000 A 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

![Diagram of 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 2000 A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures](image1)

![Diagram of Typical Main-Tie-Main Arrangement with Bus and Line VTs, and Line CPTs 5 or 15 kV VCP-W Switchgear, 3000 A Mains and Tie, 36.00-Inch (914.4 mm) Wide Structures](image2)
Typical Main-Tie-Main Arrangements (Continued)

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

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

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.

C-HRG Free-Standing
NEMA 1 Enclosure
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

1. Breakers cannot be located in bus transition compartment.

Available Configurations

Figure 5.5-4. Tie Breaker Bus Transition Requirements

- 1200 Ampere Breaker
- 2000 Ampere Breaker
- Drawout Auxiliary
- Drawout Auxiliary
- Drawout Auxiliary
- 1200 Ampere Breaker
- 2000 Ampere Breaker
- Drawout Auxiliary
- 1200 Ampere Breaker
- 2000 Ampere Breaker
- Drawout Auxiliary
- 1200 Ampere Breaker
- 2000 Ampere Breaker
- Drawout Auxiliary
- Blank (Ventilation)
- Drawout Auxiliary
- 2000 Ampere Breaker
- 3000 Ampere Breaker
- Drawout Auxiliary
- 1200 Ampere Breaker
- 3000 Ampere Breaker
- Drawout Auxiliary

Figure 5.5-5. Available Configurations

- For 4000 A forced cooled application, refer to Eaton.
- This configuration is available for indoor and outdoor walk-in designs only.

Dimensions for estimating purposes only.

For more information, visit: www.eaton.com/consultants
Typical Weights in Lb (kg)
Table 5.5-1. Assemblies (Less Breakers. See Table 5.5-2 for Breakers.)

<table>
<thead>
<tr>
<th>Type of Vertical Section</th>
<th>Main Bus Rating Amperes</th>
<th>Indoor</th>
<th>Aisleless</th>
<th>Sheltered-Aisle Including Aisle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2400</td>
<td>3200</td>
<td>4200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1090)</td>
<td>(1453)</td>
<td>(1907)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2500</td>
<td>3300</td>
<td>4300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1135)</td>
<td>(1500)</td>
<td>(1952)</td>
</tr>
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<td>2600</td>
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<tr>
<td></td>
<td></td>
<td>(1180)</td>
<td>(1545)</td>
<td>(1998)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2700</td>
<td>3500</td>
<td>4500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1226)</td>
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<td>2800</td>
<td>3600</td>
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<td>(1280)</td>
<td>(1645)</td>
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<td>2900</td>
<td>3700</td>
<td>4700</td>
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<tr>
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<td>(1340)</td>
<td>(1700)</td>
<td>(2146)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3000</td>
<td>3800</td>
<td>4800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1400)</td>
<td>(1750)</td>
<td>(2200)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3100</td>
<td>3900</td>
<td>4900</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1460)</td>
<td>(1806)</td>
<td>(2254)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3200</td>
<td>4000</td>
<td>5000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1520)</td>
<td>(1861)</td>
<td>(2310)</td>
</tr>
</tbody>
</table>

See Table 5.5-2 for breakers.

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

<table>
<thead>
<tr>
<th>Type of Breaker</th>
<th>Current Rating, Amperes</th>
<th>Approximate Weight, Lb (kg), Static</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 VCP-W 250, 25</td>
<td>350 (159)</td>
<td>410 (186)</td>
</tr>
<tr>
<td>50 VCP-W 350, 50</td>
<td>460 (209)</td>
<td>490 (222)</td>
</tr>
<tr>
<td>50 VCP-W 500, 63</td>
<td>575 (261)</td>
<td>575 (261)</td>
</tr>
<tr>
<td>75 VCP-W 500, 50</td>
<td>375 (170)</td>
<td>410 (186)</td>
</tr>
<tr>
<td>150 VCP-W 500, 25</td>
<td>350 (159)</td>
<td>410 (186)</td>
</tr>
<tr>
<td>150 VCP-W 750, 40</td>
<td>350 (159)</td>
<td>410 (186)</td>
</tr>
<tr>
<td>150 VCP-W 1000, 50</td>
<td>460 (209)</td>
<td>490 (222)</td>
</tr>
<tr>
<td>150 VCP-W 1500, 63</td>
<td>575 (261)</td>
<td>575 (261)</td>
</tr>
</tbody>
</table>

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

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. Power cable entrance area. Refer to Figure 5.5-12 for typical conduit locations. Refer to shop drawings for order specific locations.

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

2. Power cable entrance area. Refer to Figure 5.5-12 for typical conduit locations. Refer to shop drawings for order specific locations.

3. Recommended minimum clearance to rear of VacClad-W.

4. Floor steel, if used, must not exceed this dimension under VacClad-W.

5. Anchor locations: 5A and 5B for seismic applications. 5A only for non-seismic application. For indoor, use 0.5-inch (12.7 mm) bolts or weld.

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. Minimum clearance to RH side of the switchgear: 6.00 inches (152.4 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.

Dimensions for estimating purposes only.
### Dimensions in Inches (mm) (Continued)

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.00 (152.4)</td>
<td>Rear</td>
</tr>
<tr>
<td>6.00 (152.4)</td>
<td>Two Conduits per Breaker</td>
</tr>
<tr>
<td>7.00 (177.8)</td>
<td>Two Conduits per Breaker</td>
</tr>
<tr>
<td>11.50 (292.1)</td>
<td>Two Conduits per Breaker</td>
</tr>
</tbody>
</table>

#### Figure 5.5-12. Primary Conduit Locations for Stacked Breakers
1. Changes to 8.25 (209.6 mm) if optional hinged rear doors are required.
2. When cables enter from top, they connect to the breaker located in the bottom compartment. When cables enter from bottom, they connect to the breaker in the upper compartment.
3. When cables enter from top, they connect to the breaker located in the upper compartment. When cables enter from bottom, they connect to the breaker in the bottom compartment.

#### 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-function relays such as Eaton's E-series relays will significantly reduce consumption of panel space.

Dimensions for estimating purposes only.

For more information, visit: [www.eaton.com/consultants](http://www.eaton.com/consultants)
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)
Figure 5.5-16. 5/15 kV Switchgear Outdoor Common Aisle Base Plan (Typical Details)—Dimensions in Inches (mm)
5.5-8  Metal-Clad Switchgear—VacClad-W—Medium-Voltage
Drawout Vacuum Breakers

Layout Dimensions—5 kV, 26.00-Inch (660.4 mm) Wide, Indoor Only (Standard Metal-Clad)

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

Breakers cannot be located in bus transition compartment.

Figure 5.5-20. Tie Breaker Bus Transition Requirements

Available Configurations

Figure 5.5-21. Available Configurations

Typical Weights

Table 5.5-3. Switchgear Assembly (Less Breaker)

<table>
<thead>
<tr>
<th>Type of Vertical Section</th>
<th>Main Bus Rating, Amperes</th>
<th>Weight Lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/B</td>
<td>1200</td>
<td>2000 (908)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2200 (999)</td>
</tr>
<tr>
<td>B/A or A/B</td>
<td>1200</td>
<td>1700 (772)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>1900 (863)</td>
</tr>
<tr>
<td>A/A</td>
<td>1200</td>
<td>1600 (726)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>1800 (817)</td>
</tr>
</tbody>
</table>

Table 5.5-4. Circuit Breaker

<table>
<thead>
<tr>
<th>Type of Circuit Breaker</th>
<th>Current Rating, Amperes</th>
<th>Weight Lb (kg) (Static)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 VCPW-ND-250</td>
<td>1200</td>
<td>345 (157)</td>
</tr>
</tbody>
</table>

Breaker impact weight = 1.5 x static weight.

Dimensions for estimating purposes only.

For more information, visit: www.eaton.com/consultants
Dimensions in Inches (mm) (Continued)

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

1. Power cable entrance area. Refer to Figure 5.5-24 for typical conduit locations. Refer to shop drawings for order specific locations.

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

2. Power cable entrance area. Refer to Figure 5.5-24 for typical conduit locations. Refer to shop drawings for order specific locations.
3. Recommended minimum clearance to rear of VacClad-W.
4. Floor steel, if used, must not exceed this dimension under VacClad-W.
5. Anchor locations: 5A and 5B for seismic applications. 5A only for non-seismic application. For indoor, use 0.5-inch (12.7 mm) bolts or weld.
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. Minimum clearance to RH side of the switchgear: 6.00 inches (152.4 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.

Dimensions for estimating purposes only.
Dimensions in Inches (mm) (Continued)

Figure 5.5-24. Primary Conduit Locations for Stacked Breakers

1. Changes to 8.25 (209.6 mm) if optional hinged rear doors are required.
2. When cables enter from top, they connect to the breaker located in the bottom compartment. When cables enter from bottom, they connect to the breaker in the upper compartment.
3. When cables enter from top, they connect to the breaker located in the upper compartment. When cables enter from bottom, they connect to the breaker in the bottom compartment.

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-function relays such as Eaton's E-series relays 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

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

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

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)

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)

<table>
<thead>
<tr>
<th>Vertical Section Type</th>
<th>Main Bus Rating, Amperes</th>
<th>Weight Lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/A or A/B</td>
<td>1200</td>
<td>1500 (682)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>1700 (772)</td>
</tr>
<tr>
<td>A/A</td>
<td>1200</td>
<td>1400 (636)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>1600 (726)</td>
</tr>
</tbody>
</table>

Table 5.5-6. Circuit Breaker

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Current Rating, Amperes</th>
<th>Weight (Static) Lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 VCPW-ND-250</td>
<td>1200</td>
<td>345 (157)</td>
</tr>
</tbody>
</table>

Breaker impact weight = 1.5 x static weight.
Figure 5.5-31. 36.00-Inch (914.4 mm) Wide VCP-W Low Profile Indoor Unit

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)

<table>
<thead>
<tr>
<th>Vertical Section Type</th>
<th>Main Bus Rating, Amperes</th>
<th>Indoor Structure Lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B/B</td>
<td>1200 2000 3000</td>
<td>2200 (999) 2300 (1044) 2400 (1090)</td>
</tr>
<tr>
<td>B/A or A/B</td>
<td>1200 2000 3000</td>
<td>2100 (953) 2200 (999) 2300 (1044)</td>
</tr>
<tr>
<td>A/A</td>
<td>1200 2000 3000</td>
<td>1800 (818) 1900 (864) 2000 (908)</td>
</tr>
</tbody>
</table>
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](image1)

![Figure 5.5-35. Outdoor Aisleless Typical Auxiliary/Breaker Vertical Section](image2)

![Figure 5.5-36. Indoor Auxiliaries 36.00-Inch (914.4 mm) Wide Typical Auxiliary/Auxiliary Vertical Section](image3)

**Available Configurations**

![Available Configurations](image4)

**Typical Weights in Lb (kg)**

**Table 5.5-8. Assemblies (Less Breakers)**

<table>
<thead>
<tr>
<th>Type of Vertical Section</th>
<th>Main Bus Rating, Amperes</th>
<th>Indoor</th>
<th>Outdoor Aisleless</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/B</td>
<td>1200</td>
<td>2500 (1135)</td>
<td>3400 (1545)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2600 (1180)</td>
<td>3500 (1591)</td>
</tr>
<tr>
<td>A/A</td>
<td>1200</td>
<td>2200 (999)</td>
<td>2800 (1271)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>2300 (1045)</td>
<td>2900 (1317)</td>
</tr>
</tbody>
</table>

**Table 5.5-9. Breaker Weights in Lb (kg)**

<table>
<thead>
<tr>
<th>Type of Breaker</th>
<th>Current Rating, Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>2000</td>
</tr>
<tr>
<td>270 VCP-W 750</td>
<td>415 (188) 475 (216)</td>
</tr>
<tr>
<td>270 VCP-W 1000</td>
<td>415 (188) 475 (216)</td>
</tr>
<tr>
<td>270 VCP-W 1250, 25C</td>
<td>415 (188) 475 (216)</td>
</tr>
<tr>
<td>270 VCP-W 40, 40C</td>
<td>415 (188) 475 (216)</td>
</tr>
</tbody>
</table>

↑ Breaker impact = 1.5 x breaker weight.

Dimensions for estimating purposes only.
**Dimensions in Inches (mm)**

(Continued)

---

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

1. Power cable entrance area. Refer to Figure 5.5-40 for typical conduit locations. Refer to shop drawings for order specific locations.

---

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

2. Power cable entrance area. Refer to Figure 5.5-40 for typical conduit locations. Refer to shop drawings for order specific locations.

3. Recommended minimum clearance to rear of VacClad-W: 36.00 inches (914.4 mm).

4. Floor steel, if used, must not exceed this dimension under VacClad-W.

5A and 5B for seismic applications, 5A only for non-seismic application. For indoor, use 0.5-inch (12.7 mm) bolts or weld.

6. Anchor locations: 5A and 5B for seismic applications, 5A only for non-seismic application. For indoor, use 0.5-inch (12.7 mm) bolts or weld.

7. Station ground connection provision.

8. Secondary conduit space: All—maximum of 1.00-inch (25.4 mm) projection.

9. Minimum clearance to LH side of VacClad-W. Minimum clearance to RH side of the switchgear: 6.00 inches (152.4 mm).

10. Minimum clearance to front of 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.

---

Dimensions for estimating purposes only.
Dimensions in Inches (mm) (Continued)

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

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-function relays such as Eaton’s E-series relays 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

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

Available Configurations

- Available Main Bus Ratings for 27 kV two-high design are 1200 A, 2000 A, 2500 A or 2700 A.
- Bus connected, maximum 4 A fuses. CPT is installed remote from the switchgear.
- Fuses are bus or line connected. CPT is installed in front bottom, on drawout frame.
- Bus or Line connected, maximum 4 A fuses. CPT is installed remote from the switchgear.

Dimensions for estimating purposes only.
Diagram of Typical Floor Plan—27 kV Two-High, Indoor

Anchor locations for 0.50-inch (12.7 mm) bolts SAE Grade 5 or better, (6) places in each vertical section.

Secondary control wiring conduit openings, conduit projection must not exceed 1.00 inch (25.4 mm).

Minimum front clearance when using Eaton's portable lifter.

Minimum left-hinged panel clearance. Minimum clearance to RH side of the switchgear: 6.00 inches (152.4 mm).

Recommended minimum rear clearance.

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.

Primary (H.V.) conduit projection must not exceed 2.00 inches (50.8 mm). See shop order base plan for conduit locations.

Customer’s ground provisions, provided as shown by symbol on shop order sectional side views.

Dimensions for estimating purposes only.
Layout Dimensions—38 kV, 150 kV BIL Design—Dimensions in Inches (mm)

Typical Units

Figure 5.5-47. Indoor—Typical Breaker, Main or Feeder

Figure 5.5-48. Indoor—Typical Auxiliary-Over-Auxiliary

Figure 5.5-49. Indoor—Typical Bus Tie Breaker

Typical Weights in Lb (kg) *

Table 5.5-11. Assemblies (Less Breakers)

<table>
<thead>
<tr>
<th>Type of Vertical Section</th>
<th>Main Bus Rating Amperes</th>
<th>Indoor Rating Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breaker</td>
<td>1200</td>
<td>3100 (1409)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>3200 (1456)</td>
</tr>
<tr>
<td></td>
<td>2500</td>
<td>3355 (1525)</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>1200</td>
<td>3000 (1364)</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>3100 (1409)</td>
</tr>
<tr>
<td></td>
<td>2500</td>
<td>3355 (1525)</td>
</tr>
</tbody>
</table>

* Refer to Table 5.5-12 for breaker weights.

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

<table>
<thead>
<tr>
<th>Type of Breaker</th>
<th>Current Rating, Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>380 VCP-W-16, 16C</td>
<td>1080 (490)</td>
</tr>
<tr>
<td>380 VCP-W-25, 25C</td>
<td>1080 (490)</td>
</tr>
<tr>
<td>380 VCP-W-32, 32C</td>
<td>1080 (490)</td>
</tr>
<tr>
<td>380 VCP-W-40, 40C</td>
<td>1080 (490)</td>
</tr>
</tbody>
</table>

Dimensions for estimating purposes only.
Layout Dimensions—38 kV, 150 kV BIL Design—Outdoor Enclosures
(48-Inch and 60-Inch Wide Structures are Available)
Dimensions in Inches (mm)

Figure 5.5-50. Outdoor Aisleless (42.00 Inches [1066.8 mm] Wide)

Figure 5.5-51. Outdoor Sheltered Aisle (42.00 Inches [1066.8 mm] Wide)
Layout Dimensions—38 kV, 150 kV BIL Design—Dimensions in Inches (mm)

Figure 5.5-52. Typical Indoor Base Plan—38 kV

- **1.** Suggested locations for 0.500-13 bolts or welding.
- **2.** Secondary conduit location bottom entrance. Conduit projection must not exceed 1.00 inch (25.4 mm).
- **3.** Recommended minimum front clearance.
- **4.** Minimum left-hinged panel clearance. Minimum clearance to RH side of the switchgear: 6.00 inches (152.4 mm).
- **5.** Recommended minimum real clearance—follow local regulations.
- **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 switchgear.
- **7B.** Finished foundation (within 0.08-inch (2.0 mm) clearance) must extend under switchgear minimum 1.50 inches (38.1 mm) to maximum 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 shop order sectional side views.

For more information, visit: [www.eaton.com/consultants](http://www.eaton.com/consultants)
Typical Application Layouts

![Typical Arc-Resistant Switchgear Application Layouts—5 and 15 kV](image)

**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 5.5-56 to 5.5-61 for dimensions.
Typical Application Layouts

Figure 5.5-54. 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 5.5-56 to 5.5-61 for dimensions.
Figure 5.5-55. 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 5.5-56 to 5.5-61 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 2000 A breaker in this location must be limited to 1750 A.
3 = This configuration requires use of a 4000 A main bus.
4 = Maximum current through each 2000 A breaker in this configuration must be limited to 1750 A each.

Figure 5.5-56. Available Arc-Resistant Switchgear Configurations (Front Views)—5 and 15 kV
Available Configurations

Figure 5.5-56. Available Arc-Resistant Switchgear Configurations (Front Views)—5 and 15 kV (Continued)

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 2000 A breaker in this location must be limited to 1750 A.
5 = Maximum current through a 3000 A breaker in this location must be limited to 2500 A.
6 = Maximum current allowed through a 3000 A circuit breaker in this configuration is 3000 A with fans running, and 2500 A when fans are not running.
7 = Maximum current allowed through a 3000 A circuit breaker in this configuration is 4000 A with fans running, and 2500 A when fans are not running.
Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

Figure 5.5-57. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV
Figure 5.5-58. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

Arc Fault Venting
Surge Arrester, Cable Boots, and BYZ shown are optional.
Figure 5.5-59. Typical Arc-Resistant Switchgear (Side Views)—5 and 15 kV

Typical Sectional Side Views (Continued)
## 5/15 kV Arc-Resistant Switchgear—Typical Weights

### Table 5.5-13. Assemblies (Less Breakers)

<table>
<thead>
<tr>
<th>Type of Vertical Section</th>
<th>Main Bus Rating</th>
<th>Indoor Structure 9750-Inch (2476.5 mm) W 9750-Inch (2476.5 mm) D</th>
<th>Indoor Structure 109.50-Inch (2781.3 mm) D</th>
<th>Indoor Structure 121.50-Inch (3086.1 mm) D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Amperes Lb (kg)</td>
<td>Amperes Lb (kg)</td>
<td>Amperes Lb (kg)</td>
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<tr>
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<td>1200</td>
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<td>3025 (1374)</td>
<td>3175 (1441)</td>
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<td>2900 (1317)</td>
<td>3175 (1441)</td>
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<td>3275 (1487)</td>
<td>3475 (1578)</td>
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<td>4000</td>
<td>3100 (1407)</td>
<td>3375 (1532)</td>
<td>3575 (1623)</td>
</tr>
<tr>
<td>Blank/breaker or blank</td>
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<td>2800 (1271)</td>
<td>3025 (1374)</td>
<td>3175 (1441)</td>
</tr>
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<td>3375 (1532)</td>
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<td>3475 (1578)</td>
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<td>3100 (1407)</td>
<td>3375 (1532)</td>
<td>3575 (1623)</td>
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<td>Auxiliary/auxiliary</td>
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<td>3575 (1623)</td>
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<tr>
<td>Blank/auxiliary or blank</td>
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<td>2800 (1271)</td>
<td>3025 (1374)</td>
<td>3175 (1441)</td>
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<td>2900 (1317)</td>
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<tr>
<td>Blank/blank</td>
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<td>3100 (1407)</td>
<td>3375 (1532)</td>
<td>3575 (1623)</td>
</tr>
</tbody>
</table>

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 Lb (159.1 kg) for 9750-inch (2476.5) D structures.
   - 390 Lb (177.3 kg) for 109.50-inch (2781.3) D structures.
   - 430 Lb (185.4 kg) for 121.50-inch (3086.1) D structures.
3. Add plenum weight as follows:
   - 300 Lb (136.4 kg) to left and right end structures.
   - 200 Lb (91.0 kg) to each intermediate structures.
4. Add arc duct assembly weight as follows:
   - 200.00 Lb (91.0 kg) for standard 51.00-inch (1295.4 mm) arc exhaust duct assembly.
   - 30.00 Lb (14.0 kg) per foot for additional arc duct.

For more information, visit: [www.eaton.com/consultants](http://www.eaton.com/consultants)
Figure 5.5-60. 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.

© Depth shown is based on use of maximum one 500 kCM per phase, or two 250 kCM per phase power cables for each breaker entering from the top; otherwise, use structures with 121.50-inch (3086.1-mm) depth.
These are the locations of 0.75 inch (19.1 mm) diameter mounting holes for securing an arc-resistant VacClad-W switchgear assembly (hereafter referred to as VC-W) vertical section to a finished foundation. Use of 0.50 inch (12 mm) diameter SAE Grade 5 hardware tightened to 75 ft-lb (101.7 Nm) is recommended. Use of other post-installed mechanical anchor systems, bonded/adhesive type systems, pre-installed cast-in-place systems such as shear lugs, L-bolts and J-bolts, or plug welding the VC-W switchgear vertical section at the mounting hole locations to cast-in-place structural steel materials or to a steel house foundation is sole responsibility of others. Alternative mounting systems must have equal or greater average ultimate tensile and shear load capabilities as SAE Grade 5 hardware. In addition to load capabilities of the mounting system, the bearing strength and bearing surface area at each VC-W switchgear vertical section mounting hole location must be taken into account. Alternative mounting systems must provide equal or greater bearing properties as a Key Bellevilles, Inc., K1125-E-125 washer or other manufacturer’s equal device used with SAE Grade 5 hardware at each VC-W switchgear anchor location. Consult a licensed structural or civil engineer prior to selecting a mounting system if a system other than that recommended is preferred.

Minimum front clearance required when using Eaton’s portable lifter to install drawout devices. If other Eaton devices are used to install drawout devices, these devices may require more space, which will be indicated on an arc-resistant VC-W switchgear assembly specific shop order floor plan. In addition, the local authority having jurisdiction may also require a larger distance.

Minimum left-hinged panel clearance. Minimum clearance to RH side of the switchgear: 6.00 inches (152.4 mm).

This is the minimum rear clearance required. The local authority having jurisdiction may require a larger distance.

Location of low-voltage control conduit wiring openings. Conduits are limited to a projection of 1.00 inch (25.4 mm) above the finished floor or inside the top cover when such conduit entry is from the top. Maximum conduit size is 1.25 inches (31.8 mm).

These are the high-voltage cable conduit entry locations when entering from the floor or the top. See shop order base plan for recommended conduit locations when bottom entry is being used. Conduit projection must not exceed 2.00 inches (50.8 mm).

This is the location of the cable lug for attaching the cable from the customer’s ground grid. In the first and last vertical section in an arc-resistant VC-W switchgear assembly, the grounding grid cable should enter through the HV cable conduit entry area in the floor and be routed to this terminal lug.

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.
Figure 5.5-62. Typical Transition to Eaton's Arc-Resistant MVS and Ampgard MV MCC
Typical Application Layouts

Figure 5.5-63. 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 5.5-64 to 5.5-66 for dimensions.
4. 27 kV arc-resistant switchgear can be supplied in one-high design configuration only.
Available Configurations (Continued)

Figure 5.5-64. 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 Lb (kg) 2

Table 5.5-14. Assemblies (Less Breakers)

<table>
<thead>
<tr>
<th>Type of Vertical Section</th>
<th>Main Bus Rating Amperes</th>
<th>Indoor Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control/breaker</td>
<td>1200 2000</td>
<td>2700 (1226)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2800 (1271)</td>
</tr>
<tr>
<td>Control/auxiliary</td>
<td>1200 2000</td>
<td>2400 (1090)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2500 (1135)</td>
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</tbody>
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2 Refer to Table 5.5-9 for breaker weights.
Typical Sectional Side Views—Dimensions in Inches (mm)

Figure 5.5-65. Typical Arc-Resistant Switchgear Sectional (Side Views)—27 kV
Typical Arc-Resistant Switchgear Floor Plan—27 kV

Figure 5.5-66. Typical Arc-Resistant Switchgear Floor Plan—27 kV
Typical Application Layouts

Notes:
1. Maximum # of CTS:
   - Bus Side
     2 sets of standard or 1 set of high accuracy
   - Line/Cable side
     3 sets of standard or 1 set of standard and 1 set of high accuracy
2. CT mounting bushings on bus side are provided only when bus side CTs are included.
3. Bottom entry is standard for all power cables. Contact Eaton if top entry is required.
4. Refer to Figure 5.5-68 to 5.5-70 for dimensions.

Figure 5.5-67. Typical Arc-Resistant Switchgear Application Layouts—38 kV
Available Configurations

Figure 5.5-68. Available Arc-Resistant Switchgear Application Layouts (Front Views)—38 kV

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

Typical Weights in Lb (kg)

Table 5.5-15. Assemblies (Less Breakers)

<table>
<thead>
<tr>
<th>Type of Vertical Section</th>
<th>Main Bus Rating</th>
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<td>3000</td>
<td>4000 (1816)</td>
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<tr>
<td>Auxiliary cell</td>
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<tr>
<td>2000</td>
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</table>

Refer to Table 5.5-12 for breaker weights.
Figure 5.5-69. Typical Arc-Resistant Switchgear Sectional (Side Views)—38 kV
Figure 5.5-70. Typical Arc-Resistant Switchgear Floor Plan—38 kV
Arc Exhaust Wall—for 27 and 38 kV Switchgear

Arc Exhaust Wall is installed above the gear in the field. Minimum required clearance above the arc wall = 48 (1219.2)

Arc Exhaust Wall

Note-1 = Arc Exhaust Wall is installed above the gear in the field.
Note-2 = Minimum required clearance above the arc wall = 48 (1219.2)

Note-2

H Swgr

Front View

Figure 5.5-71. Arc Exhaust Wall Above the Switchgear

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

Arc Exhaust Chamber (Plenum) is installed above the gear in the field. Minimum recommended clearance for field installation = 18.00 (457.20)

Arc Duct can exit from any of the locations marked “A”

Note-1

Note-2

H Swgr

Front View

Figure 5.5-72. Arc Exhaust Chamber (Plenum) with Arc Duct Exit Above the Switchgear

Arc Exhaust wall Figure 5.5-71 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 5.5-73 and 5.5-74 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

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 Arc-Resistant Switchgear—Exhaust Layout

**Typical Layout—Dimensions in Inches (mm)**

![Diagram of Arc-Resistant Switchgear]

**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.

**Figure 5.5-73. Typical Layout of 5/15 kV Arc-Resistant Switchgear Inside Electrical Room and Outside Minimum Exhaust Area**
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 prior to opening any switchgear rear doors.

For the layout shown, doors on the house wall (not shown) provide access to rear of the switchgear. For rear access to switchgear from within the house, minimum 36.00 (914.4) clearance is required behind the switchgear.

Figure 5.5-74. Typical Layout of 5/15 kV Arc-Resistant Switchgear Inside an Outdoor House (Electrocenter)
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