

MV metal-enclosed fusible switchgear



Description

MVS (load interrupter) switchgear is an integrated assembly of switches, bus, and fuses that are coordinated electrically and mechanically for medium voltage circuit protection. All major components are manufactured by Eaton, establishing one source of responsibility for the equipment's performance and for ensuring high standards in quality, coordination, reliability, and service.

A complete line of Eaton switches and fuses is available, as follows:

- 5, 15, 27, and 38 kV voltage classes
- 600A continuous and load interrupting ratings, all voltage classes, 1200A continuous and load interrupting for 5 and 15 kV classes
- Non-fused or fused with current limiting or boric acid-type fuses
- Manual or motor operated
- Indoor or outdoor non-walk-in enclosures
- Single switches and transformer primary switches
- Duplex load break switch arrangements for selection of alternate feeds

- Two-position, manual no-load selector switches for selection of alternate feeds (5 and 15 kV only)
- Lineups with main bus
- Standard arrangements with automatic transfer control systems, two sources feeding one load, or two sources feeding two loads on a split bus with tie switch

Standard design configurations for:

- NEMA® pads for cable lugs
- Surge arresters
- Instrument transformers
- Control power transformers
- IQ electronic metering
- PowerNet™ accessing devices such as addressable relays and PONI cards
- Other auxiliary equipment

Application

Eaton load interrupter (Type MVS) metal-enclosed switchgear provides safe, reliable switching and fault protection for medium voltage circuits rated from 2.4 kV through 38 kV. The MVS switch is ideal for applications where high duty cycle operation is not needed.

MVS switchgear has the advantage of low initial cost inherent in switch designs while offering the characteristics most vital to safety and coordination.

The MVS switch's quick-make, quick-break mechanism provides full-load current interrupting capability while fuses provide accurate, permanently calibrated short-circuit detecting and interrupting capabilities. Visibility of actual blade position improves safety by giving positive assurance of circuit de-energization.

MVS switchgear meets or exceeds the following industry standards: ANSI/IEEE® C37.20.3, ANSI C37.22, ANSI C37.57, ANSI C37.58, NEMA SG5.

MVS switchgear assemblies are available as listed products with Underwriters Laboratories (UL®) or Canadian Standards Association (CSA®) with a variety of options.

MVS switchgear assemblies are available seismically labeled to meet the seismic zone 4 requirements of either UBC or California Title 24 or BOCA® (Building Officials and Code Administration, International).

Load interrupter switches should not be used for interrupting fault currents, phase or ground, as they are neither designed nor tested for interrupting fault currents on electrical systems. For ground fault current tripping, see MEB switchgear, section C2 of CAT.71.01.T.E or TD.45B.01.T.E.

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Construction

- ① Switch mechanism. Quick-make, quick-break stored energy operation.

The opening and closing of the switch blades is done by the operating spring. An operator's actions only charge and release the operating spring.

The switch blades cannot be teased to any intermediate positions. During the closing operation, full clearance between the blades and the stationary contacts is maintained until the switch mechanism goes over toggle.

The switch mechanism has only metal-to-metal linkage—no chains or cables are used.

Arc interruption takes place between copper-tungsten tipped auxiliary (flicker) blade and arcing contacts within a DE-ION® arc chute; no arcing takes place between the main blades and the stationary contacts.

Blow out forces cannot be transmitted to the operating handle.

- ② Provisions for padlocking door.
- ③ Inspection window. A single gasketed, rectangular, high-impact viewing window permits full view of the position of all three switch blades through the closed door.
- ④ Full height main door. The door has a return flange, is reinforced, and has two rotary latch-type handles to provide latching members held in shear. It closes over a projecting frame.
- ⑤ Foot-operated door stop.
- ⑥ Grounded metal safety barrier. Prevents inadvertent contact with any live part, yet it allows full-view inspection of the switch blade position.
- ⑦ Door interlock. Prevents the door of the enclosure from being opened when the switch is closed.
- ⑧ Switch interlock. Prevents inadvertent closure of the switch if the door of the enclosure is open.
- ⑨ High-quality insulation. Bus and switch insulators, switch drive rods barriers between phases, and barriers between outer phases and the housing are of high-strength, non-hygroscopic, track-resistant glass polyester as standard.
- ⑩ Red-green switch position indicators.
- ⑪ Provisions for padlocking switch open or closed.
- ⑫ Provisions for door and switch key interlocks.
- ⑬ The operating handle. It is conveniently located behind a small access door, giving the structure a smooth homogeneous appearance and discouraging casual contact by unauthorized personnel.
- ⑭ Switchgear assembly rating nameplate.

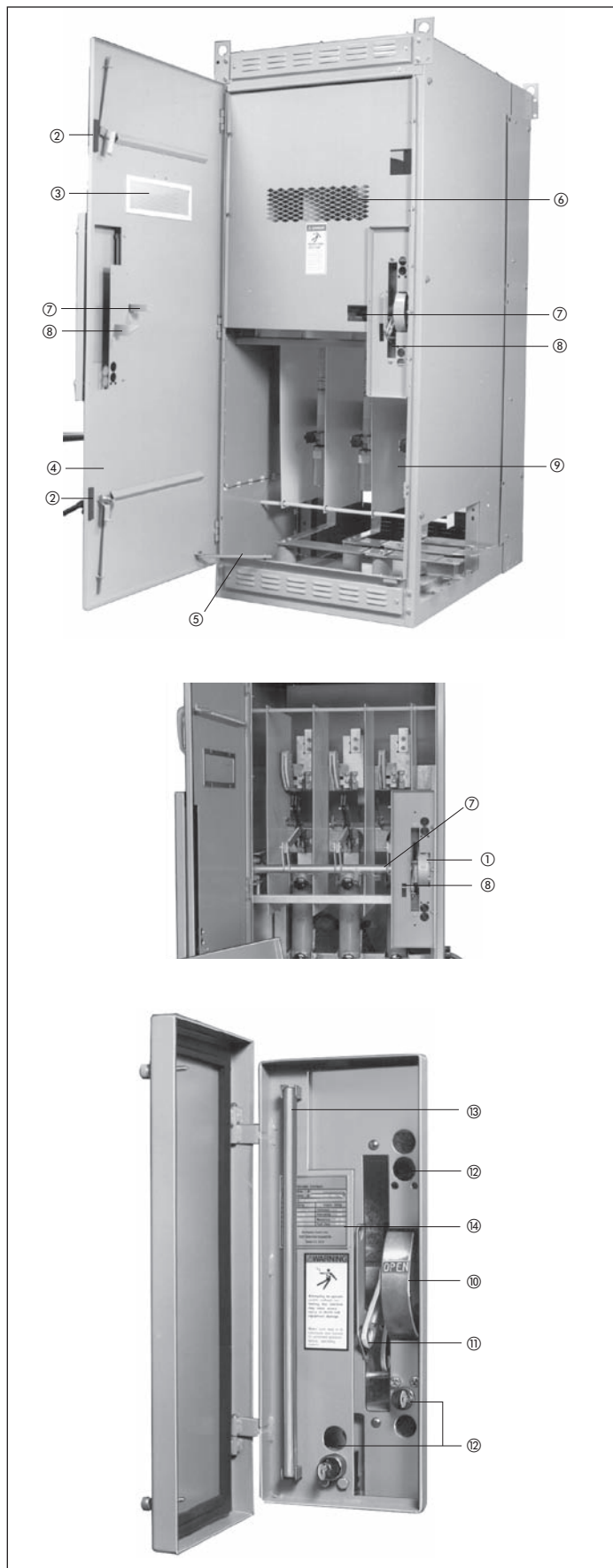


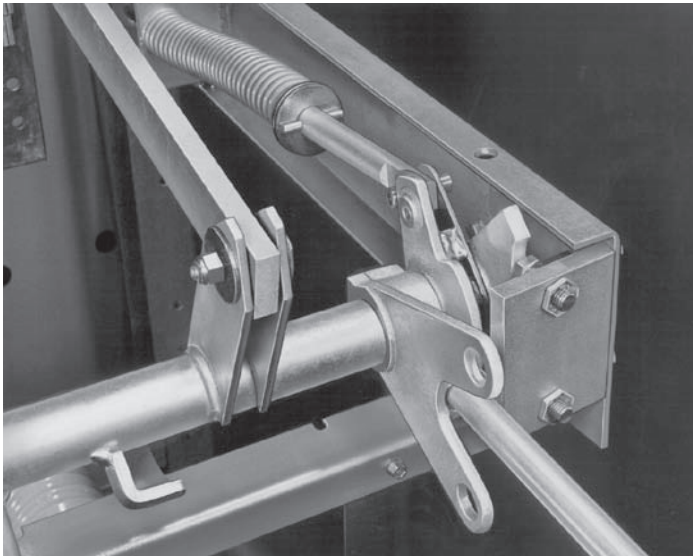
Figure 1. MV Construction

Switch mechanism

The quick-make, quick-break mechanism uses a heavy-duty coil spring that provides powerful opening and closing action. To close the switch, the handle is inserted into the spring charging cam, then rotated upward through an angle of 120 degrees. This action charges the operating spring, and as the mechanism is forced past toggle, the stored energy of the spring is released and transferred to the main shaft that snaps the switch closed.

As a result of the over-toggle action, the blades are moved independently of the operator. It is impossible to tease the switch into any intermediate position.

To open the switch, the handle is inserted into the spring charging cam and rotated downward through 120 degrees, charging the operating spring, then releasing its stored energy in similar sequence.



Spring being charged

Quick-break DE-ION arc interruption

With the switch closed, both the main and auxiliary (flicker) blades are closed, and all of the current flows through the main blades. The flicker blades are in the closed position in the arc chutes, but are past the arcing contacts and thus carry no current.

As the main blades open, current is transferred momentarily to the flicker blades, which are held in the arc chutes by high-pressure contact fingers. There is no arcing at the main blades.

When the main blades reach a pre-determined angle of opening, a stop post on the main blades prevents further angular movement between the main and flicker blades. This starts the flicker blades out of the high-pressure contacts in the arc chutes and as contacts are broken, the flicker blades are snapped into position by their torsion springs.

The heat of the arc, meanwhile, releases a blast of de-ionizing gas from the gas-generating material of the arc chute. This combination of quick-break and DE-ION action quickly extinguishes the arc and the circuit is safely de-energized.

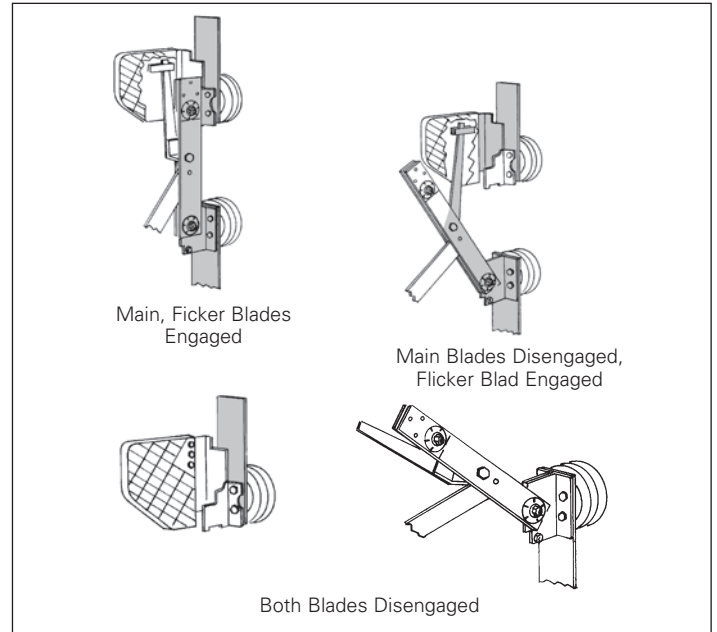


Figure 2. Flicker Blades

Two-position, no-load selector switch

The MVS load interrupter switch can be provided with a two-position non-load break selector switch. This selector switch is mechanically interlocked such that operation can be performed only when the load interrupter switch is in the open position. Also, neither the MVS switch nor the main door can be closed without the selector switch being positively locked in one of the two feeder positions.

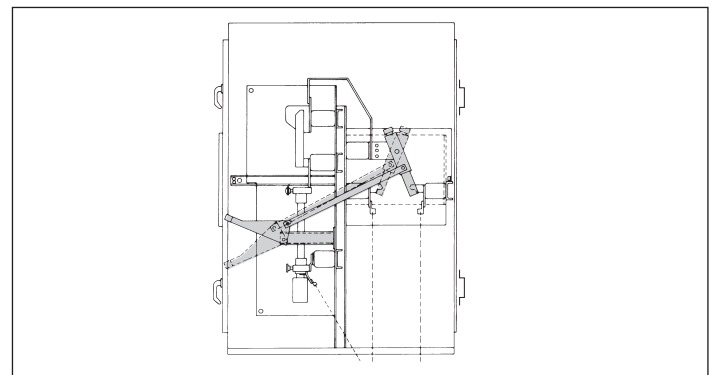


Figure 3. Typical Two-Position Selector Switch for Bottom Cable Entrance

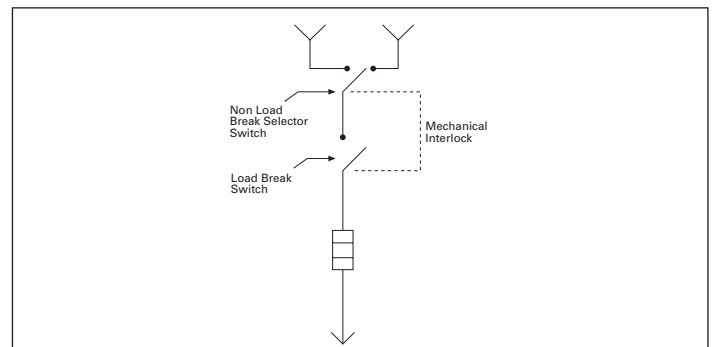


Figure 4. Typical Selector Switch Configuration

Duplex switch configuration

Two MVS load interrupter switch sections can be provided with a common load side bus feeding one load, fused or non-fused. Key interlocks are a standard feature provided to permit only one switch to be closed at one time and to prevent opening any switch door unless both switches are open.

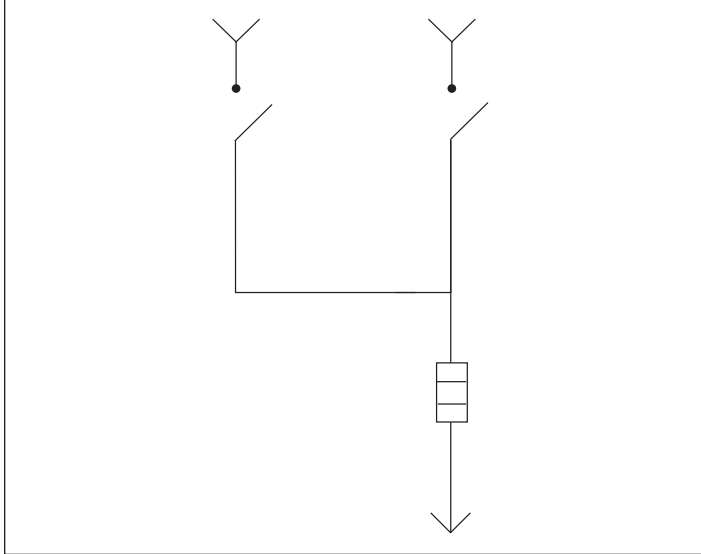


Figure 5. Typical Duplex Switch Configuration

Motor-operated MVS switches

Application

The MVS Pow-R-Drive motor operator makes possible the safety, convenience, and coordination inherent in remote switch operation.



Description

An MVS Pow-R-Drive motor-operated switch is a standard, manually operated switch in combination with a heavy-duty electric motor-driven linear actuator that charges the spring. The linear actuator is located in a separate isolated low voltage compartment. During electrical operation, it smoothly and quietly extends or retracts the proper distance to cause the switch mechanism to operate.

Standard motor operators are mounted in the switch enclosure. This eliminates the separate motor compartment, conserving floor space.



Manual operation

A steel clevis pin connects the linear actuator to the spring charging mechanism. This pin can be removed by hand and the linear actuator pivoted away from the mechanism, allowing manual operation.

Key interlock to lock switch open

The keyed locking bolt can only be extended when the switch is in the open position. When the switch is closed, the shaft interlock cam prevents the switch from being locked in the closed position.

Extending the bolt not only locks the switch in the open position, but it also breaks electrical motor contacts integral to the lock and permits the key to be removed. With the key, the operator can then open the lock on the switch door. This scheme gives positive assurance that the switch is open and cannot be closed with the door open.

MVS switchgear with automatic transfer control



Two-switch automatic transfer

Application

MVS switchgear with an automatic transfer control system is an integrated assembly of motor-operated MVS switches, sensing devices, and control components. Available in 5 through 38 kV classes.

It is typically applied where the continuity of service for critical loads from two power sources in either a two-switch (one load) or three-switch (two loads) configuration is desired.

MVS switchgear with an automatic transfer control system can meet most automatic throw-over requirements as it has a wide variety of operational sequences embodied in one standard automatic transfer control system.

IQ Transfer controller

The IQ Transfer is equipped to display history information either via the front panel or over PowerNet. Source 1 and Source 2 run time, available time, and connect time are available, as well as load energized time, number of transfers, and the date, time, and reason for the last 16 transfers.

For communications capability, the IQ Transfer can be equipped with a PON1 card that will allow the user to communicate with the unit via Series III software. All settings for purchased options can be set from the faceplate of the unit or downloaded over PowerNet. Series III software allows for the charting of key historical data, as well as providing the capability to monitor and to control the transfer switch from a remote location.



IQ Transfer

Typical two-switch operation IQ Transfer controller

The IQ Transfer controller continuously monitors all three phases on both sources for correct voltages. Should the voltage of the normal source be lost while the voltage of the alternate source remains normal, the voltage sensing function in the IQ Transfer will change state starting the time delay function. If the voltage of the normal source is not restored by the end of the time delay interval, the normal switch will open and the alternate source switch will close restoring power to the load.

Typical three-switch operation

The MVS automatic transfer controller continuously monitors all three phases on both sources for correct voltages. Should the voltage of either source be lost, the failed source voltage sensing relays will change state starting the time delay function. If the voltage of the normal source is not restored by the end of time delay interval, the failed source switch will open and then the tie switch will close. Both load buses are then fed from the remaining source.

Standard features

- Voltage sensing on both sources (two-switch uses IQ Transfer, three-switch uses voltage relays)
- Lights to indicate status of switches, sources, and so on
- Interlocking to prevent paralleling of sources via software
- Control power for the automatic transfer control system is derived from the sensing voltage transformers
- Manual override operation
- Selectable closed or open transition on return to normal
- Programmable time delays on both sources, "OFF DELAY" and "ON DELAY"
- Single-source responsibility: all basic components are manufactured by Eaton
- Key interlocking of operating system and doors where required to provide operator safety

Optional features

- Lockout on phase and/or ground overcurrents and/or internal bus faults



Figure 6. Electronic Metering and Communications Apparatus

Electronic metering

MVS switchgear assemblies can be equipped with Eaton’s IQ family of electronic meters to monitor a power circuit’s electrical quantities within the capabilities of each device. See section B1 of CAT.71.01.T.E for more information on these devices. MVS switchgear assemblies can also be equipped to interface with Eaton’s PowerNet integrated monitoring and control communications system with PON1 accessories, Addressable Relays, and so on. See section B5 of CAT.71.01.T.E for more information.

Outdoor enclosures

Weatherproofing complying with the requirements of NEMA 3R and IEEE standard C37.20.3 is available for MVS switchgear assemblies. The weatherproofing consists of sloped roof panels that are joined together with caps. Doors and rear covers are fully gasketed. Externally accessible louvered filtered covers, top and bottom, front and rear, are provided for ventilation. At least one 250 watt heater is provided in each vertical section. Power for the heaters may be supplied from an external source, or an optional integral control power transformer may be specified to provide power for the heaters.

Layout arrangements

The arrangements and accompanying tables in this section represent the most common switchgear arrangements. Many other configurations and combinations are available (contact Eaton for more information). Dimensions of vertical sections will vary if cabling is different from a maximum of two 500 kcmil, XLP or EPR insulated cables per phase using preformed slip-on cable termination devices, and/or if devices such as surge arresters, instrument transformers, special cable termination devices, and so on, are required. For unit substation applications, see section D2 of CAT.71.01.T.E or TD.49A.02A.T.E.

Table 1. Approximate Weights

Switch Description	Indoor Lbs	Outdoor Lbs
5 or 15 kV Class		
Non-fused switch	1500	1800
Fuses (three), add	200	200
Indoor transition	300	—
Outdoor throat	—	500
25.8 or 38 kV Class		
Non-fused switch	2000	2400
Fuses (three), add	300	300
Indoor transition	1100	—
Outdoor throat	—	1200
Motor operator adder	400	400

Layout A: MVS arrangements, cable-in cable-out (single unit)

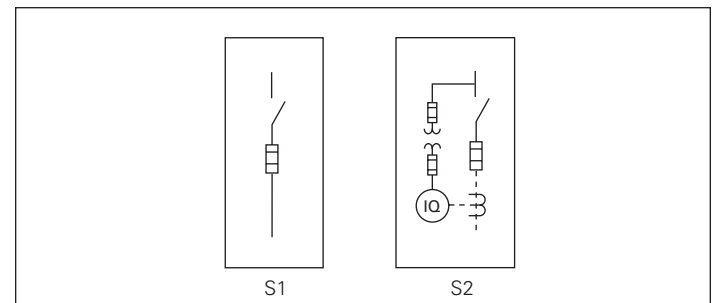


Figure 7. Layout A

Table 2. Layout A

kV Class	Fusing ①	Cable		Width		Height				Depth ④	
		In ②	Out ②	F ③	R ③	Indoor F ③	Indoor R ③	Outdoor F ③	Outdoor R ③	S1	S2
5 or 15	None or CL or RBA	T	T or B	36	36	100.4	90.4	N/A	95.5	55.3	62
		B	T or B	56	36	90.4	90.4	N/A	95.5	55.3	62
27 or 38	RBA	T	T or B	48	48	137	127	N/A	135	80	100
		B	T or B	78	48	127	127	N/A	135	80	100
	None or CLX	T	T or B	48	48	111.5	101.5	N/A	110	80	100
		B	T or B	78	48	101.5	101.5	N/A	110	80	100

Note: Dimensions in inches. Not to be used for construction purposes unless approved.

① CL—Eaton Current Limiting Fuse.

RBA—Eaton Expulsion Fuse.

CLX—Non-Eaton Current Limiting Fuse.

② T = Top entry of power cable.

B = Bottom entry of power cable.

③ F = Front only access for installing power cables.

R = Rear access for installing power cables.

④ Height must always match the tallest vertical section in complete switchgear assembly.

Layout B: Multiple vertical section arrangements (lineups) ⑥

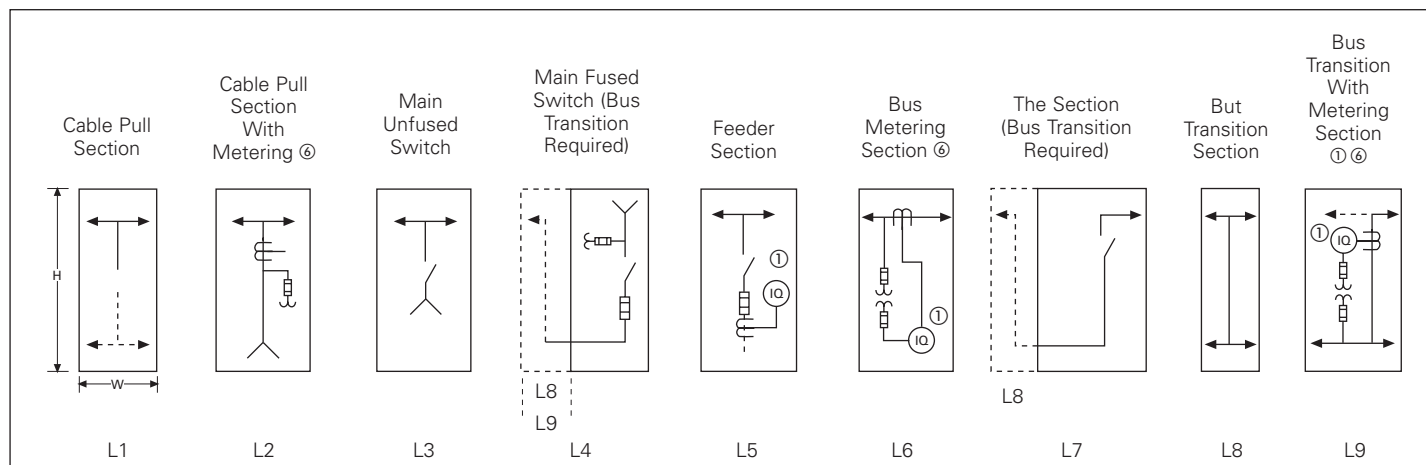


Figure 8. Layout B

Table 3. Layout B

kV Class	Figure	Fusing Type ②	Cable In/Out	Cable Access F/R ④ ⑤	Cable Direction T/B ③	Width	Height		Depth ⑦
							Indoor	Outdoor	
5 or 15	L1	N/A	In or out	F or R	T or B	20	90.4	95.5	55.3
	L2	N/A	In or out	F or R	T or B	36 ⑥	90.4	95.5	55.3
	L3	None	In	F or R	T or B	36	90.4	95.5	55.3
	L4	CL or RBA	In	F	T	36 (42) ⑩	100.4	N/A	55.3
	L4		In	F	B	56 (62) ⑩	90.4	N/A	55.3
	L4		In	R	T or B	36 (42) ⑩	90.4	95.5	55.3
	L5	CL or RBA	Out	F or R	T or B	36 (42) ⑩	90.4	95.5	55.3
	L6	N/A	N/A	N/A	N/A	36	90.4	95.5	55.3
	L7	N/A	N/A	N/A	N/A	36	90.4	95.5	55.3
L8	N/A	N/A	N/A	N/A	15	90.4	95.5	55.3	
L9	N/A	N/A	N/A	N/A	36 ⑥	90.4	95.5	55.3	
27 or 38	L1	N/A	In or out	F or R	T or B	30	101.5 ⑧ ⑨	110 ⑧ ⑨	80
	L2	N/A	In or out	F or R	T or B	48 ④	101.5 ④ ⑧	110 ④ ⑧	80
	L3	None	In	F or R	T or B	48	101.5 ⑧	110 ⑧	80
	L4	RBA or CLX	In	F	T	48	137	N/A	70 ⑧
	L4		In	F	B	78	127	N/A	70 ⑧
	L4		In	R	T or B	48	127	135	70 ⑧
	L5	CLX	Out	F or R	B	48	101.5 ⑧	110 ⑧	70
	L5		Out	F	T	48	101.5 ⑧	110 ⑧	80
	L5		Out	F or R	B	48	127	135	70
	L5		Out	F	T	48	127	135	80
	L6	N/A	N/A	N/A	N/A	48	101.5 ⑧	110 ⑧	70
	L7	N/A	N/A	N/A	N/A	48	101.5 ⑧	110 ⑧	70
	L7		N/A	N/A	N/A	48	127	135	70
	L8	N/A	N/A	N/A	N/A	30	101.5 ⑧	110 ⑧	70
	L9	N/A	N/A	N/A	N/A	48	127	135	90

Note: Dimensions in inches. Not to be used for construction purposes unless approved.

① Optional metering. Current transformers and IQ Meter. Voltage for operation to be obtained from voltage transformer instrument bus in switchgear or voltage transformers in the section.

② CL—Eaton Current Limiting Fuse.
RBA—Eaton Expulsion Fuse.
CLX—Non-Eaton Current Limiting Fuse.

③ T = Top entry of power cable.
B = Bottom entry of power cable.

④ F = Front only access for installing power cables.
R = Rear access for installing power cables.

⑤ Cannot mix front and rear accessible structures.

⑥ When used for utility metering, larger dimensions may be necessary.

⑦ Depth of any vertical section must always match depth of deepest vertical section. Depths shown are for rear covers. Add 1.2 for optional rear doors.

⑧ Height must always match the tallest vertical section in complete switchgear assembly.

⑨ When VTs are required, depth must be 100.00 inches.

⑩ Vertical section widths may vary for all Eaton disconnect mounted fuses, and Eaton CLE-1100 fuses.

Layout C: Manual main-tie main

Available with feeder switches or cable in and out.

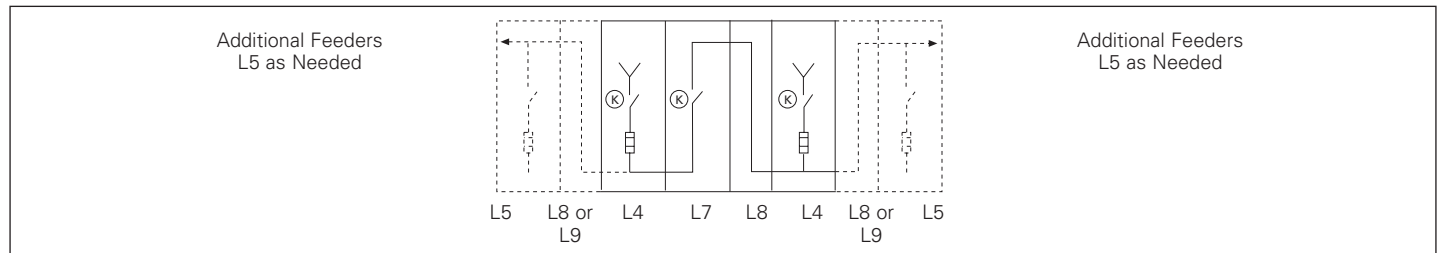


Figure 9. Layout C

Table 4. Layout C

kV Class	Fusing ①	Cable Access F/R ②	Cable Direction T/B ③	Width	Height		Depth
					Indoor	Outdoor	
5 or 15	None or CL or RBA	R	T or B	See Table 3	90.4	95.5	55.3
		F	B		90.4	N/A	55.3
		F	T		100.4	N/A	55.3
27 or 38	None	R	T or B	See Table 3	101.5 ④	110 ④	80
		F	B		101.5 ④	N/A	70
		F	T		111.5 ④	N/A	70
	CLX or RBA	R	T or B	See Table 3	127	135	80
		F	B		127	N/A	70
		F	T		137	N/A	70

Layout D: Automatic transfer control assemblies

Available with feeder switches or cable in and out.

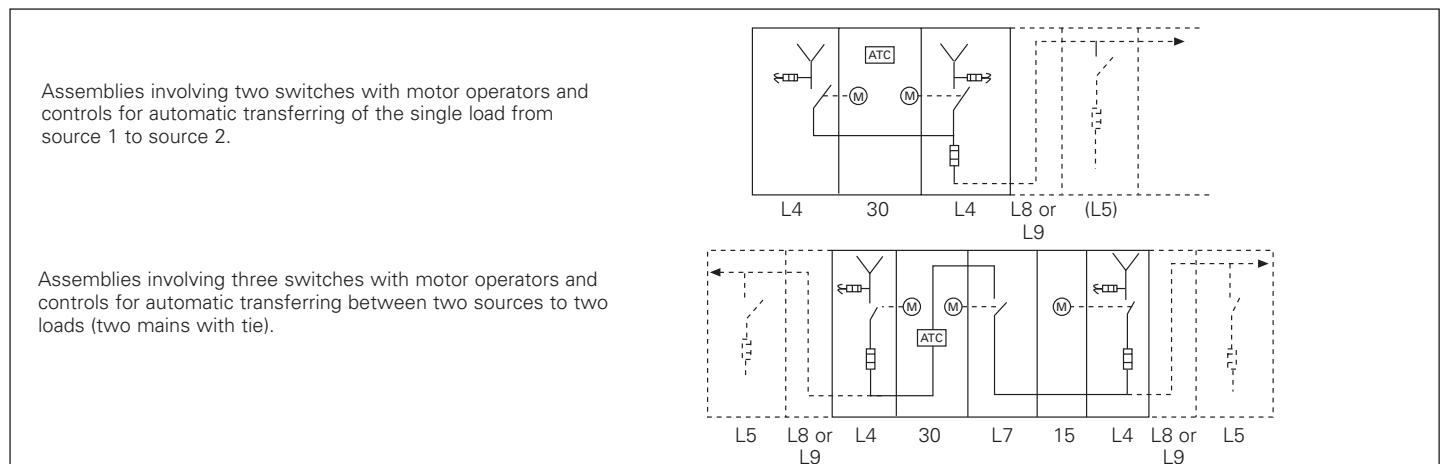


Figure 10. Layout D

Table 5. Layout D

kV Class	Fusing ①	Cable Access F/R ②	Cable Direction T/B ③	Width	Height		Depth
					Indoor	Outdoor	
5 or 15	None or CL or RBA	R	T or B	See Table 3	90.4	95.5	55.3
		F	B		90.4	N/A	55.3
		F	T		100.4	N/A	55.3
27 or 38	None	R	T or B	See Table 3	101.5 ④	110 ④	100
		F	B		101.5 ④	N/A	100
		F	T		111.5 ④	N/A	100
	CLX or RBA	R	T or B	See Table 3	127	135	100
		F	B		127	N/A	100
		F	T		137	N/A	100

Note: Dimensions in inches. Not to be used for construction purposes unless approved.

① CL—Eaton Current Limiting Fuse. RBA—Eaton Expulsion Fuse. CLX—Non-Eaton Current Limiting Fuse.

② F = Front only access for installing power cables. R = Rear access for installing power cables.

③ T = Top entry of power cable. B = Bottom entry of power cable.

④ Height must always match the tallest vertical section in complete switchgear assembly.

Layout E: Selector switch arrangement ①

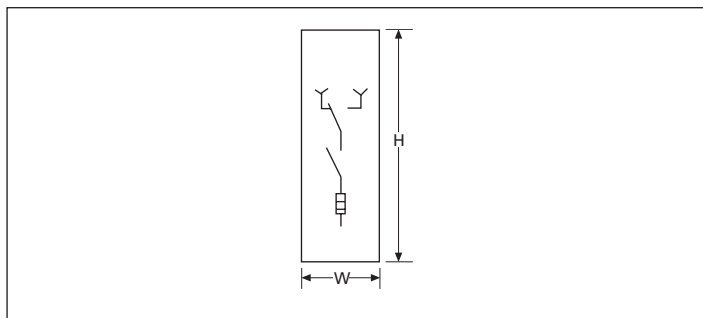


Figure 11. Layout E

Table 6. Layout E

Rear access always required.

kV Class	Fusing ②	Entering Cable Direction ③	Exiting Cable Direction ③	Width (W)	Height (H)		
					Indoor	Outdoor	Depth
5	None	T	T	36	90.4	95.5	70
	or CL or RBA	T	B	36	90.4	95.5	62
		B	B	36	90.4	95.5	62
		B	T	36	90.4	95.5	70
15	None	T	T	36	90.4	95.5	80
	or CL or RBA	T	B	36	90.4	95.5	70
		B	B	36	90.4	95.5	62
		B	T	36	90.4	95.5	80

Layout F: Duplex arrangement

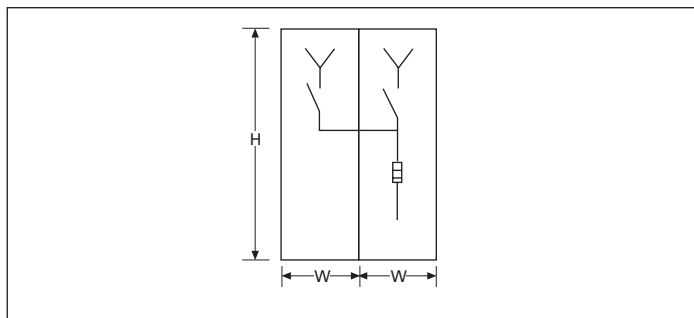


Figure 12. Layout F

Table 7. Layout F

Class	Fusing ②	Entering Cable Direction ③	Exiting Cable Direction ③	Width (W)	Height (H)		
					Indoor	Outdoor	Depth
5 or 15	None or CL or RBA	T or B	T or B	36	90.4	95.5	62
27 or 38	RBA or CLX	T or B	T or B	48	127	135	100

Layout G: Motor-operated switches

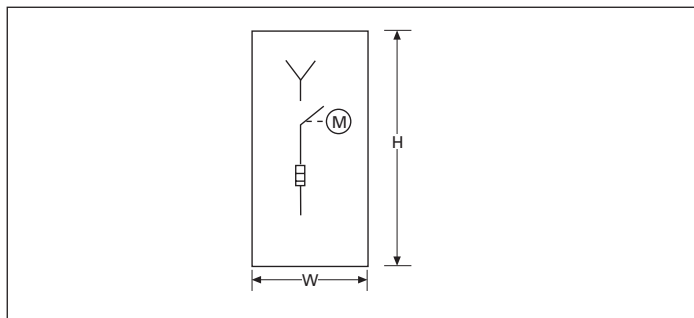


Figure 13. Layout G

Optional motor operator does not change dimensions of MVS switchgear. See Layout D for automatic transfer control type assemblies for exceptions.

Note: Dimensions in inches. Not to be used for construction purposes unless approved.

- ① 5 kV and 15 kV only.
- ② CL—Eaton Current Limiting Fuse.
RBA—Eaton Expulsion Fuse.
CLX—Non-Eaton Current Limiting Fuse.
- ③ T = Top entry of power cable.
B = Bottom entry of power cable.

Layout H: Assemblies involving connections to other apparatus

Connections to transformers—see section D2 of CAT.71.01.T.E or TD.49A.02.T.E.

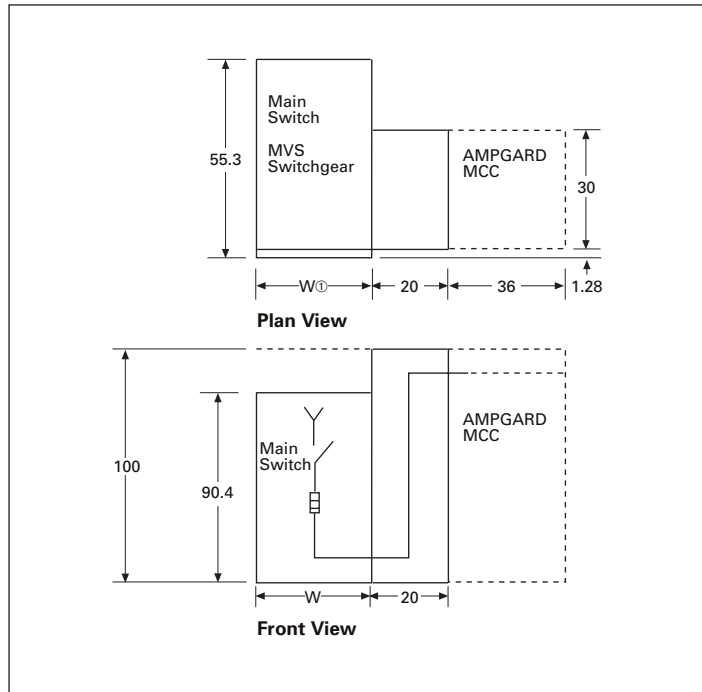


Figure 14. Connections to AMPGARD MCC (7.2 kV Max. Only)

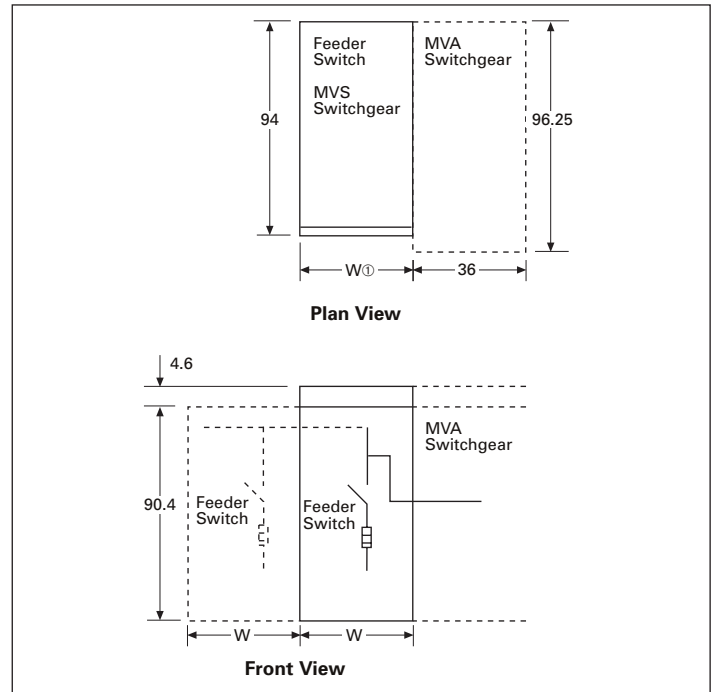


Figure 16. Connection to MVA Switchgear Assembly (5 or 15 kV Only)

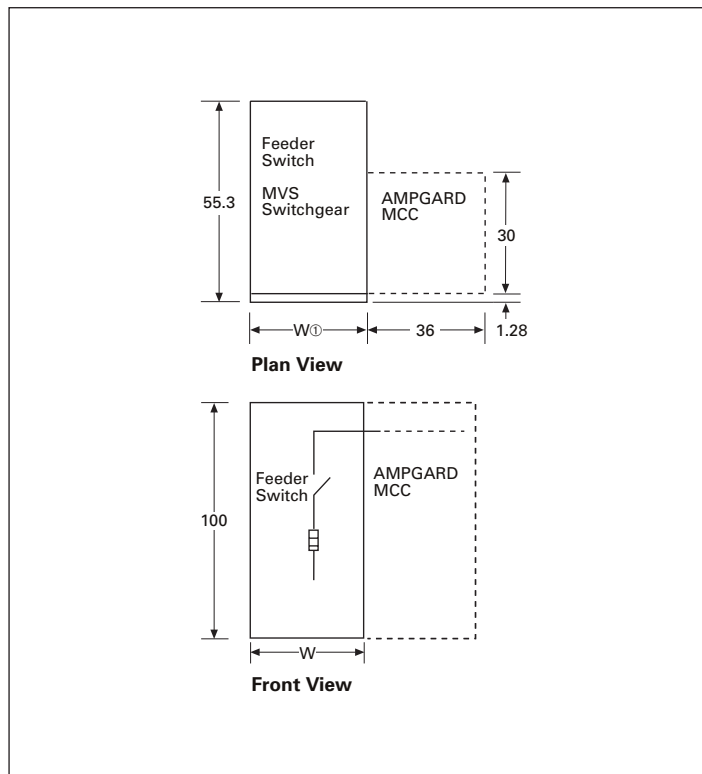


Figure 15. Connections to AMPGARD MCC (7.2 kV Max. Only)

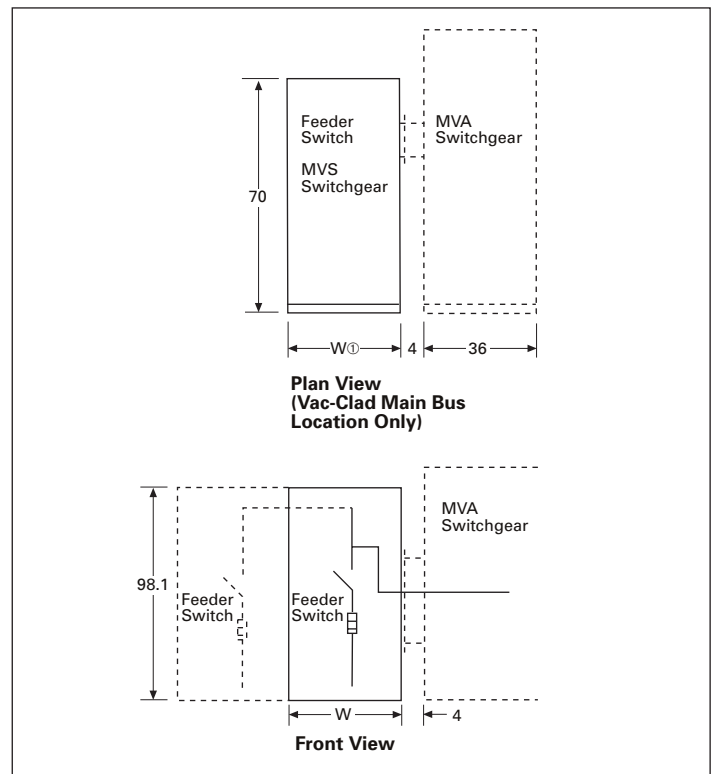


Figure 17. Connection to MVA Switchgear Assembly (5 or 15 kV Only)

Note: Dimensions in inches. Not to be used for construction purposes unless approved.

① See **Table 3.**

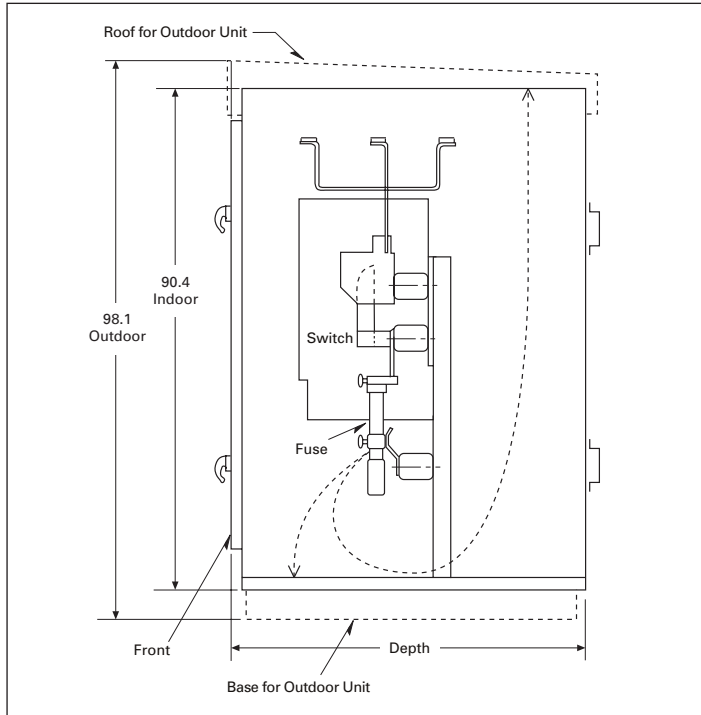


Figure 18. 5, 15 kV Switches with Main Bus

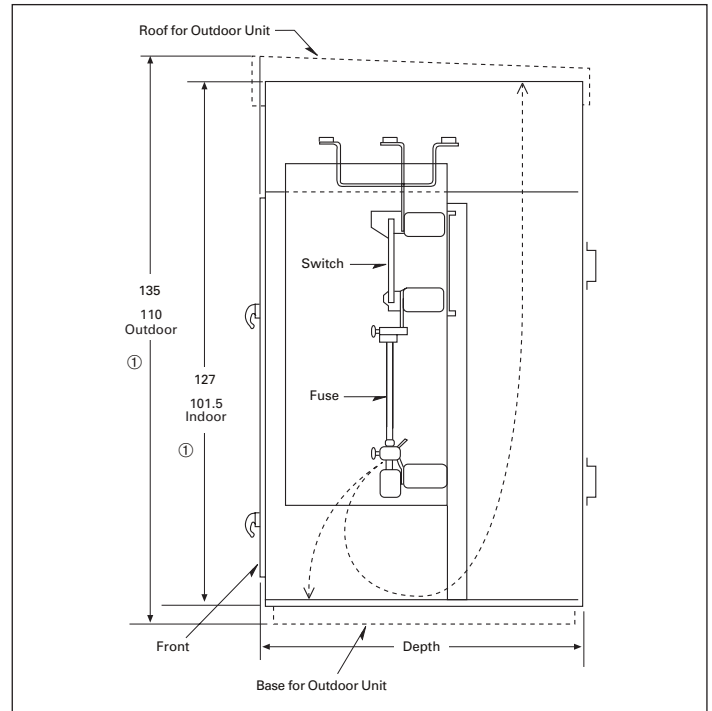


Figure 20. 27, 38 kV Switches with Main Bus

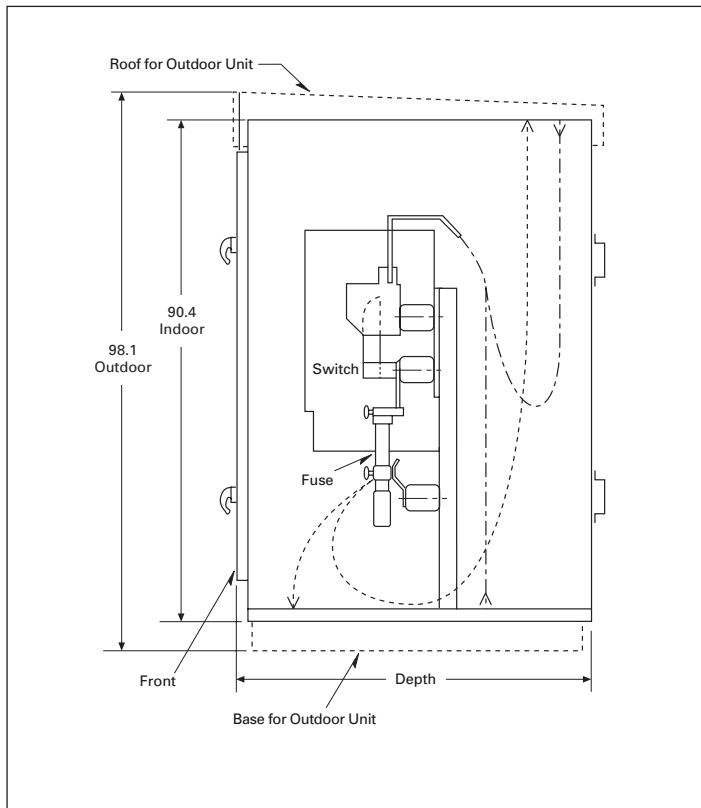


Figure 19. 5, 15 kV Switches without Main Bus

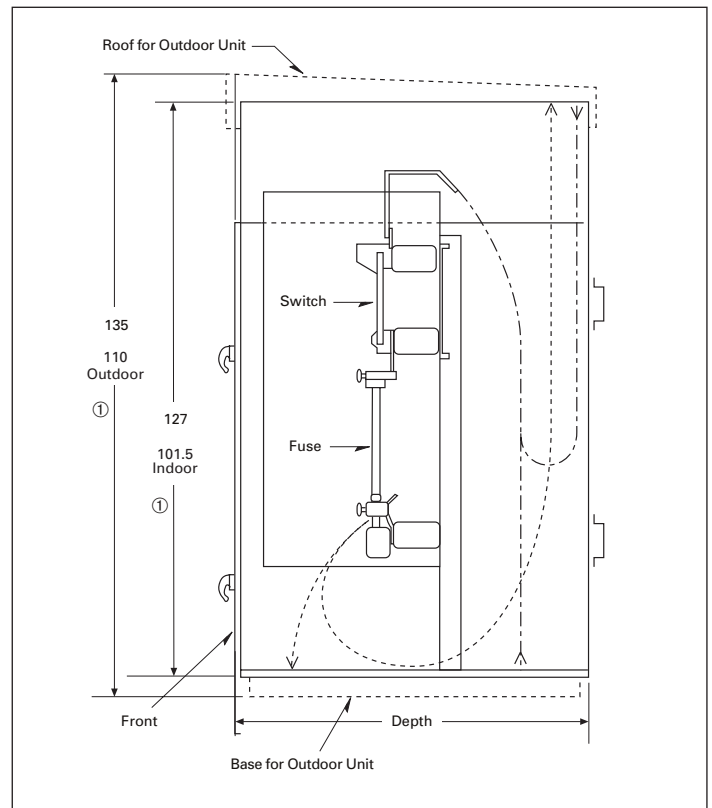


Figure 21. 27, 38 kV Switches without Main Bus

Note: Dimensions in inches. Not to be used for construction purposes unless approved.

① 110 and 101.5 inch dimensions are for non-fused switches, or switches with current limiting fuses. When RBA fuses are used, the switches will be shipped in two sections.

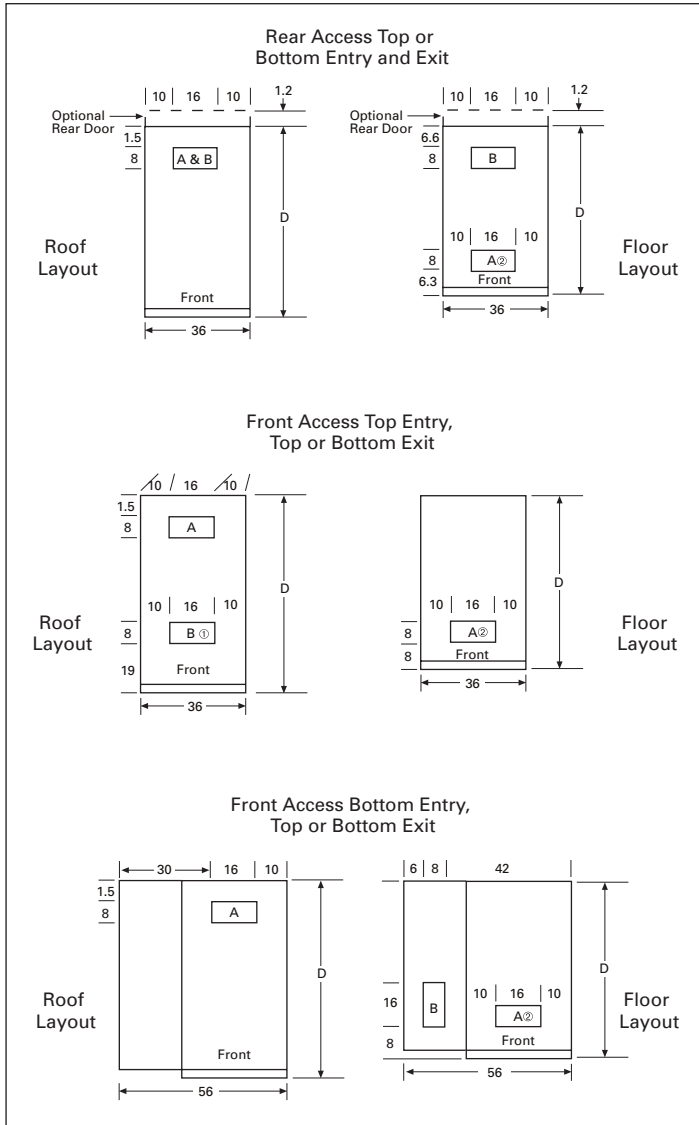


Figure 22. 5 and 15 kV Roof Layouts and Floor Layouts

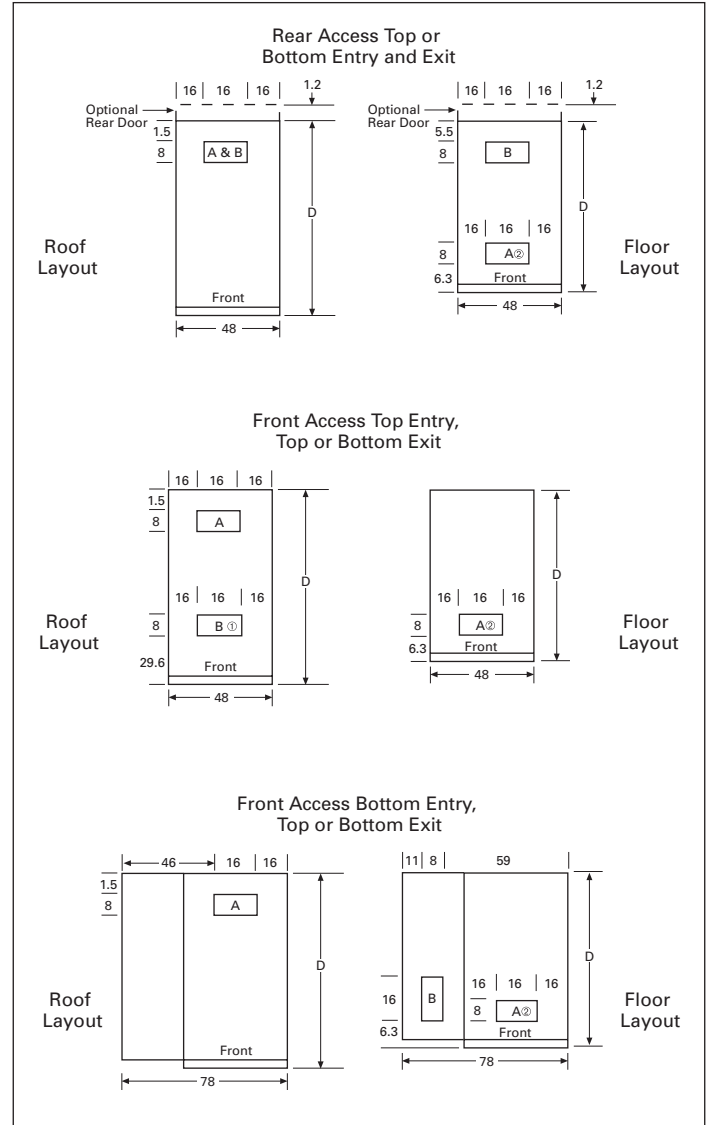


Figure 23. 27 and 38 kV Roof Layouts and Floor Layouts

Notes: A = Power cable to load. B = Power cable from source. See **Tables 2-7** as applicable for dimension D on Pages 7-10. Dimensions in inches. Not to be used for construction purposes unless approved.

① Cable location not available with top main bus.

② When high continuous current fusing or instrumentation is required, consult Eaton factory for guidance.

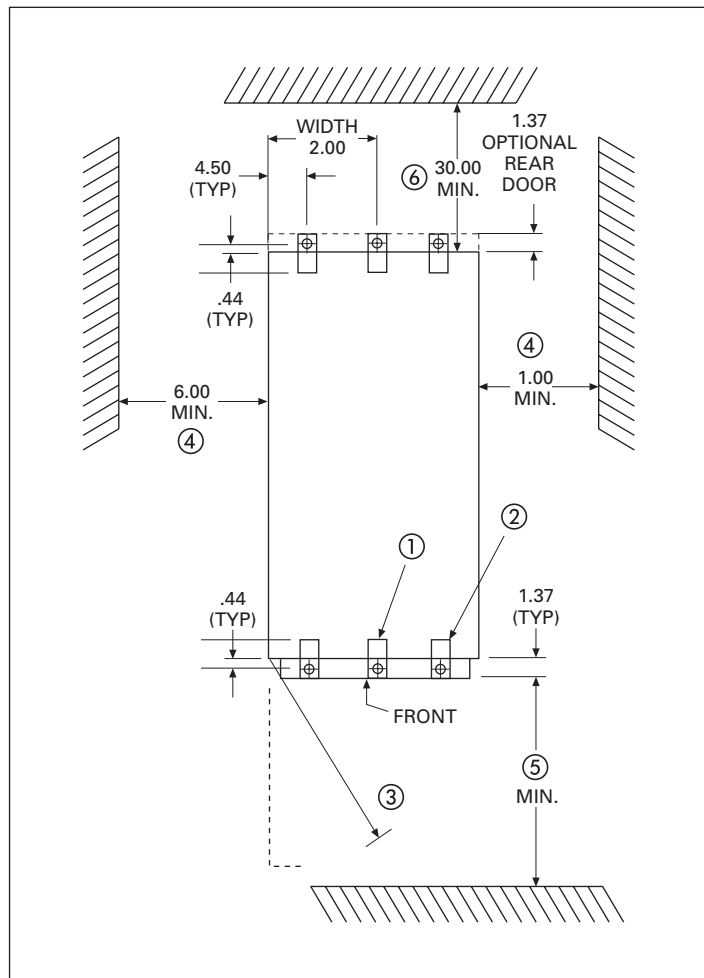


Figure 24. Typical Anchor Plan for Outdoor Vertical Sections

- ① Locations for tie-down clips. There are two tie-down clips for nonseismic applications.
- ② Locations for tie-down clips. There are four tie-down clips for seismic applications. Customer provided bolts for anchoring should be 0.50-13 SAE Grade 5 or stronger, and torqued to 75 ft-lbs.
- ③ Door swing equals vertical section width at 90 degrees.
- ④ Minimum clearance on side. Local jurisdictions may require a larger clearance.
- ⑤ Minimum clearance in front is the width of the widest vertical section plus 1.00 inch. Local jurisdictions may require a larger distance.
- ⑥ Minimum clearance in rear is 30.00 inches. If rear doors are supplied, the minimum clearance is the width of the widest vertical section equipped with a rear door plus 1.00 inch. Local jurisdictions may require a larger clearance.
- ⑦ Finished foundation under the switchgear must be flat, level and in true plane.

Technical data

Test Data

All MVS switch ratings have been thoroughly tested in recognized high-power laboratories. Tests were performed to substantiate all published ratings in accordance with ANSI, IEEE, CSA, and NEMA standards.

The testing program included tests of:

- Basic impulse levels
- Momentary withstand
- Short-time withstand
- Fault closing
- Load interrupting at various loads and various power factors
- Mechanical life tests
- Temperature rise test

These tests verified not only the performance of the switch and integrated switch-fuse assembly, but also the suitability of the enclosure venting, rigidity, and bus spacing.

The mechanical life test subjected the MVS switch to a number of no load cycles greater than the requirements tabulated in ANSI C37.22 standards. There were no moving or current carrying part failures as a result.

Surge protection

IEEE standard C62.11 for metal oxide surge arresters lists the maximum rated ambient temperature as 40°C. The ambient temperature inside an MVS switchgear vertical section may exceed this temperature, especially in outdoor applications where solar radiation may produce a significant contribution to the temperature. **Table 11** lists the recommended minimum duty cycle voltage rating for various system grounding methods.

Table 8. Switch Ratings

Rated Maximum kV	Impulse Withstand kV	Continuous and Load-Break Amperes	Fault-Close and Momentary Amperes kA rms Asym. (10 cyc.)	Rated Short-Time Current (2 Seconds) kA rms Sym.
5	60	600	40	25
5	60	600	61	38
5	60	1200	40	25
5	60	1200	61	38
15	95	600	40	25
15	95	600	61	38
15	95	1200	40	25
15	95	1200	61	38
27	125	600	40	25
27	125	600	61	38
38	150	600	40	25

Table 9. Switchgear Assembly Ratings

Rated Maximum Volts kV	Rated BIL kV	Rated Main Bus Current Amperes	Rated Momentary Current kA rms Asym.	Rated Short-Time Current (2 Seconds) kA rms Sym.
5	60	600–2000	40	25
5	60	600–2000	61	38
5	60	600–2000	80	50
15	95	600–2000	40	25
15	95	600–2000	61	38
15	95	600–2000	80	50
27	125	600–1200	40	25
27	125	600–1200	61	38
38	150	600–1200	40	25

Table 10. Primary Fuses, Standard Ratings ①

Fuse Type	Switchgear Rated Maximum Voltage, kV	Fuse Rated Continuous Current Range, Amperes	Rated Interrupting Capacity kA Sym.
RBA-200	5	10–200	19
RBA-400	5	0.5–400	37.5
RBA-800	5	0.5–720	37.5
CLE	5	20–450	50
CLE600/750	5	600–750	40
RBA-200	15	10–200	14.4
RBA-400	15	0.5–400	29.4
RBA-800	15	0.5–720	29.4
HRBA-400	14.4	0.5–400	34.8
HRBA-800	14.4	0.5–720	34.8
CLE	15	20–250	50
RBA-200	27	10–200	6.9
RBA-400	27	0.5–300	16.8
RBA-800	27	0.5–540	16.8
Cooper NX	27	0.5–100	35
RBA-200	38	10–200	6.9
RBA-400	38	0.5–300	16.8
RBA-800	38	0.5–540	16.8
GE EJO	38	20–80	12.5

Table 11. Suggested Minimum Ratings (kV) for Metal Oxide Surge Arresters Located in Metal-Enclosed Switchgear ②

System Grounding	Nominal System Line-to-line Voltage (kV)											
	2.4	4.16	4.8	7.2	12.0	12.47	13.2	13.8	14.4	22.9	24.9	34.5
Solidly grounded systems	3	6	6	6	12	12	12	12	12	21	24	30
Low resistance grounded systems	3	6	6	6	12	12	12	12	12	21	24	30
High resistance	6	6	9	12	18	18	21	21	24	36	39	54

① For additional fuse data and coordination curves, refer to fuse documents in section C4 of CAT.71.01.T.E.

② Surge arrester rating is based upon the ambient air temperature in the switchgear vertical section not exceeding 55°C.

Ratings

Switchgear assembly ratings shall be as follows:

Maximum design voltage—5, 15, 27, 38 kV

Basic impulse level—60, 95, 125, 150 kV

System voltage—kV three-phase (three) (four) wire (solid)

System grounding (UL and CSA certification requires solid grounding—(low resistance) (high resistance) (ungrounded))

Main bus current ratings (when equipped with main bus) and switch ratings

Switch continuous/load break—600, 1200 amperes

Momentary current (10 cycles asymmetrical)—40, 61 kA

Two-second current—25, 38 kA symmetrical

Fault close—40, 61 kA asymmetrical

Construction

- A. The metal-enclosed load interrupter switchgear shall consist of deadfront, completely metal-enclosed vertical sections containing load interrupter switches and fuses (where shown) of the number, rating, and type noted on the drawings or specified herein.
- B. The following features shall be supplied on every vertical section containing a three-pole, two-position open-closed switch:
 1. A high-impact viewing window that permits full view of the position of all three switch blades through the closed door.
 2. The door shall be interlocked with the switch so that:
 - a. The switch must be opened before the door can be opened.
 - b. The door must be closed before the switch can be closed.
 3. A grounded metal barrier in front of every switch to prevent inadvertent contact with any live part, yet allow for a full-view inspection on the switch blade position.
 4. Provision for padlocking the switch in the open or closed position.
 5. Red-green open-closed switch position indicators.
- C. Vertical section construction shall be of the universal frame type using die formed and bolted parts. All enclosing covers and doors shall be fabricated from steel whose thickness shall be equal to or greater than those specified in ANSI/IEEE C37.20.3. To facilitate installation and maintenance of cables and bus in each vertical section, a removable top cover and [(a) removable rear cover(s)] [a rear door latched closed by tamper-resistant padlockable latches] shall be provided.
- D. Each vertical section containing a switch shall have a single, full-length, flanged front door and shall be equipped with two (2) rotary latch-type padlockable handles. Provision shall be made for operating the switch and for storing the removable handle without opening the full length door. The switch operating handle shall be covered by a hinged door to discourage casual contact by unauthorized personnel.
- E. Each load interrupter switch shall have the following features:
 1. Three-pole gang operated.
 2. Manual quick-make, quick-break over-toggle-type mechanism that does not require the use of a chain or a cable for operation, and uses a heavy-duty coil spring to provide opening and closing energy.
 3. The speed of opening and closing the switch shall be independent of the operator, and it shall be impossible to tease the switch into any intermediate position under normal operation.
 4. Separate main and break contacts to provide maximum endurance for fault close and load interrupting duty.

5. Insulating barriers between each phase and between the outer phases and the enclosure.
6. A maintenance provision for slow closing the switch to check switch blade engagement and slow opening the switch to check operation of the arc interrupting contacts.

Bus

- A. All phase bus conductors shall be (tin-plated aluminum) (silver-plated copper) and rated (600) (1200) (2000) amperes continuously.
- B. Ground bus conductor shall be [tin-plated aluminum] [silver-plated copper] and be directly fastened to a bare metal surface of each vertical section, and be of a size sufficient to carry the rated (2-second) current of the switchgear assembly.
- C. A neutral bus shall be provided only when indicated on the drawings. It shall be insulated for 1000 volts AC to ground. The current rating of the neutral bus shall be 600A.

Wiring/terminations

- A. One (1) terminal pad per phase shall be provided for attaching contractor-supplied cable terminal lugs for a maximum of two (2) conductors per phase of the sizes indicated on the drawings. Sufficient space shall be supplied for contractor supplied electrical stress relief termination devices.
- B. Small wiring, fuse blocks and terminal blocks within the vertical section shall be furnished as indicated on the drawings. Each control wire shall be labeled with wire markers. Terminal blocks shall be provided for customer connections to other apparatus.

Fuses

- A. Fault protection shall be furnished by fuses as shown in the contract documents. The fuses shall have a minimum interrupting rating of ____ amperes symmetrical at ____ kV and shall be Eaton [current limiting type][expulsion type]. Furnish three (3) spare [fuses] [refills] for each fused switch. Fuse/switch integrated momentary and fault close ratings specified shall have been verified by test.

Utility metering

- A. Where indicated on the drawings, each utility metering vertical section shall contain provisions for current transformers and voltage transformers as required by the utility. The construction shall conform to the utility company's metering standards. It shall also conform to the general electrical and construction design of the switchgear specified above.

Customer metering

- A. Provide customer metering devices where shown on the drawings. Where indicated, provide a separate customer metering compartment with front hinged door. Include associated instrument transformers.
- B. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- C. Potential transformers including primary and secondary fuses with disconnecting means shall be provided for metering as shown on the drawings.
- D. Microprocessor-based metering system.

Select devices as required for item D. Refer to section B1 of CAT.71.01.T.E for detailed specification for metering.

- IQ Analyzer
- IQ DP-4000
- IQ Generator
- IQ 200

Accessories

- A. Supply key interlocks as shown on the drawings.
- B. ___ kV [station] [intermediate] [distribution] class surge arresters shall be provided connected at the incoming terminations and securely grounded to the metal structure as shown on the drawings.

Enclosures

- A. Each outdoor vertical section shall have a sloped weatherproof roof. All openings shall be screened to prevent the entrance of small animals and filtered to inhibit the entrance of snow, sand, and so on. A minimum of one (1) 250-watt, 120V space heater shall be provided in each vertical section. Power for the space heater(s) shall be furnished (as indicated on the drawings) (by a control power transformer mounted in the switchgear) (by a transformer mounted within the low voltage switchboard/switchgear). The design shall be non-walk-in type. Normal access covers shall have two rustproof handles for ease of handling.

Nameplates

- A. A nameplate shall be mounted on the front door of each switch vertical section in accordance with the drawings.

Finish

- A. Prior to assembly, all enclosing steel shall be thoroughly cleaned and phosphatized. A powder coating shall be applied electrostatically, then fused on by baking in an oven. The coating is to have a thickness of not less than 1.5 mils. The finish shall have the following properties:

Impact resistance (ASTM D-2794)—60 direct/60 indirect

Pencil hardness (ASTM D-3363)—H

Flexibility (ASTM D-522)—Pass 1/8-inch mandrel

Salt spray (ASTM B117-85 [20])—600 hours

Color gray—ANSI 61

Miscellaneous devices

- A. Motor operators, where indicated on the drawings, shall have the following features:
 - 1. All motor-operated switches shall consist of a standard manually operated switch in combination with an electric motor driven linear actuator that charges the spring. Connection between the linear actuator and switch mechanism shall be by reliable rigid metal-to-metal linkages; not chains or cables. The linear actuator and all associated low voltage wiring shall be located in a low voltage compartment or barriered to separate it from the high voltage.
 - 2. Operating voltage shall be 120V, 60 Hz available (from a fused control transformer) (from an external source as shown on the drawings). The switch shall be capable of manual operation should loss of control power be encountered.
 - 3. The linear actuator shall be a highly repetitively manufactured item, completely sealed and weather protected, and designed for rugged industrial application. No lubrication or adjustments shall be necessary for its normal operating life. The motor shall be equipped with an automatically reset thermal overload protector.

- B. Communication equipment, where indicated on the drawings, shall have the following features:
 - 1. The communication system shall be Eaton PowerNet.
 - 2. Each load interrupter switch position (open and closed), where shown, shall be communicated via an addressable relay. This relay shall communicate over a local area network consisting of a twisted pair of shielded wires. The relay shall monitor an auxiliary switch contact that monitors the primary switch position and shall be rated for the application. Each relay shall have a unique address so that it is possible to "call up" and "read" each load interrupter switch's position from a host computer.
 - 3. A blown high voltage fuse condition on each set of three (3) nondisconnect mounted fuses shall be monitored by an Addressable Relay. Any blown fuse operation shall be communicated immediately over a local area network via the monitoring Addressable Relay over a twisted pair of shielded wires. Each relay shall have a unique address so that it is possible to "call up" and "read" a fuse blown operation for a set of fuses with the communication system.

Special switchgear configurations

- A. Non-load break selector switches
 - 1. For 5 or 15 kV ratings, furnish non-load break selector switches where shown on contract drawing. A two-position non-load break interrupter switch for the selection of two incoming sources shall be provided. The selector switch shall have the same continuous current rating as the load interrupter switch. Interlocking shall be supplied so that the selector switch can only be operated with the load interrupter switch in the open position. Also, neither the main door nor the load interrupter switch shall be able to be closed without the selector switch being positively locked in one of the two feeder positions.
- B. Duplex switchgear assembly
 - 1. Furnish, where shown on the drawings, a duplex switchgear assembly configuration consisting of two (2) load interrupter switches with common load side bus to feed one load circuit, which shall be fused or unfused as indicated on the drawings. Key interlocks shall be supplied to prevent paralleling the incoming sources, and to prevent opening the front door of each vertical section containing one of the two switches unless both switches are locked open.

C. Automatic transfer control relay

1. Furnish, where shown on the drawings, a switchgear assembly with automatic transfer control relay system for two (2) mains with common load bus. The switchgear assembly shall consist of a deadfront, metal-enclosed and integrated assembly including two (2) load interrupter switches with motor operator as herein after specified, and an automatic transfer control relay system containing sensing devices, low voltage logic control, and auxiliary equipment, as indicated on the drawings. The automatic transfer control relay system, when put into "automatic" mode, shall automatically transfer the load bus circuit to the alternate power source upon failure on the preferred source. The following features shall be incorporated:
 - a. Two (2) sets of "line side" voltage transformers with primary and secondary fuses to provide both sensing and control power.
 - b. The automatic IQ Transfer controller relay system which contains:
 1. An automatic/manual mode selector switches.
 2. IQ Transfer controller for voltage sensing of each source, logic control, and indication of closed switch.
 3. One (1) open-close control switch for manual electrical operation of each load interrupter switch.
 - c. If the switchgear is operating in the "automatic" mode with manual return to normal source pre-selected, the normal source has failed and the automatic IQ Transfer controller has performed a transfer to the alternate source, the normal source has been restored, then the alternate source fails, the automatic transfer control relay shall perform an open transition retransfer to the preferred source to keep the load bus energized.
 2. Furnish, where shown on the drawings, a switchgear assembly with automatic transfer control relay system for two (2) mains and normally open tie. The automatic transfer switchgear shall consist of a deadfront, metal-enclosed and integrated assembly including two (2) main load interrupter switches and one (1) tie load interrupter switch each being driven by a motor operator hereinafter specified, and an automatic transfer control relay system containing sensing devices, low voltage logic control and auxiliary equipment, as indicated on the drawings. Operation shall be such that upon loss of voltage to the line side of a main, that main shall open and then the tie shall close. The following features shall be incorporated:
 - a. Line side voltage transformers with primary and secondary fuses to provide both sensing and control power.
 - b. The automatic transfer control relay system which contains:
 1. An automatic/manual mode selector switch.
 2. Four (4) relays for sensing voltage, two (2) for each source.
 3. Programmable logic controller for providing timing and logic to control opening and closing of the load interrupter switches.
 4. Open and closed indicating lights for each load interrupter switch.
 5. One (1) open-close control switch for manual electrical operation of each load interrupter switch.
 6. A switch to permit a choice of automatic or manual return to the normal condition of the two mains closed and the tie open.
 7. A switch to permit a choice of closed transition operation or open transition operation for return to the normal condition if automatic return to normal condition has also been selected above.
 8. Two (2) test pushbuttons to simulate loss of voltage on either source to test automatic transformer operation.
- c. If the switchgear is operating in the "automatic" mode with manual return to the normal condition of the two mains closed and the tie open selected, one of the sources has failed and the automatic transfer controls have performed opening the affected main load interrupter switch and closing the tie load interrupter switch, the power to the affected main has been restored, then the power source to the other main fails, the automatic transfer controls shall perform an open transition transfer of opening the other main load interrupter switch, then reclosing the first main load interrupter switch to restore power to all loads.

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