

Reduce the arc flash hazard in your substation with Eaton's MSB, featuring the Arcflash Reduction Maintenance System



Eaton's MSB (metal-enclosed switch and breaker combination) is an integrated assembly using reliable, cost-effective load interrupter switches in series with VCP-TR vacuum circuit breakers. MSB combines the reliable visible disconnect of a load-break switch with the superior protection capabilities of a fixed-mounted vacuum circuit breaker.

MSB can be used as the primary protection for a single-ended substation (eliminating the need for a secondary main breaker), or it can be used as the primary main device and integrated into a lineup of fused MVS switchgear.

Arc flash hazard reduction

Safety is crucial and standards like NFPA® 70E (Standard for Electrical Safety in the Workplace) have emerged, making it unacceptable for engineers to accept existing or to design new unit substations without considering the impact of arc flash hazards and secondary bus protection. Eaton's MSB delivers an elegantly simple design approach. MSB offers primary transformer protection and secondary bus protection in one 15 kV class primary metal-enclosed assembly.



Arc Flash and PPE



Powering Business Worldwide

Unit substation dilemma

For the past 30 to 40 years, engineers have designed secondary unit substations based on application of a 15 kV metal-enclosed fused load-break switch, close coupled to a transformer primary, then in turn connected to low voltage switchgear at the transformer secondary.

National Electrical Code® (NEC®) requirements for this class of equipment contained two statements that resulted in quite a few unit substations being installed with very high levels of available arcing energy unprotected on the secondary bus of the transformers. Those two statements were:

- Note 2 of NEC Article 450.3 Equipment—Transformers describes the “six disconnect rule.” This article states, “Where secondary overcurrent protection is required, the secondary overcurrent device shall be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location.”
- NEC Article 240.21(C)2 Overcurrent Protection describes transformer secondary conductors not over 10 ft (3m) long such that the ampacity of the secondary conductors is not less than the combined calculated loads on the circuits supplied by the secondary conductors.

These two articles in the Code resulted in thousands of unit substations being installed using a fused load-break switch as the secondary bus protection!

The emergence of new electrical safe workplace standards such as the NFPA 70E–2009 has challenged users to take another look at their substations based on the incident energy or arc flash hazard should a secondary bus fault occur. This could happen while doing energized work such as racking a secondary feeder circuit breaker on or off of an energized bus.

NFPA 70E arc flash hazard calculations conducted at one industrial site yielded arc flash energies in excess of 700 calories/centimeter² at the secondary bus as shown in the substation diagram below. Because personal protective equipment (PPE) available at the site was only rated up to Category 4, 40 calories/centimeter², there was no safe condition in which an operator could insert or remove a feeder circuit breaker from an energized bus in order to perform lockout/tagout safety procedures.

MSB is the solution to the arc flash hazard dilemma

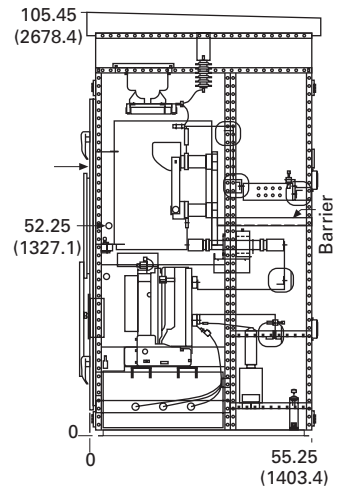
Reduce arc flash hazard in your substation with Eaton’s MSB. Solving this electrical safety hazard involved replacement of the existing metal-enclosed fused load-break switch with an Eaton metal-enclosed medium voltage switch over vacuum circuit breaker (MSB) assembly. MSB is perfect for retrofit in existing substations where arc flash safety is an issue. And, the MSB is perfect for application in new substations.

With MSB, sensors can be installed on the secondary bus that are connected into the primary vacuum circuit breaker. MSB can effectively provide primary substation transformer protection as well as secondary switchgear bus protection using one device.

The VCP-T main circuit breaker can be equipped with multiple user preferred methods for arc energy reduction, drastically reducing the arc flash energy on the secondary bus for any unit substation.

Two available methods for reducing incident arcing energy are:

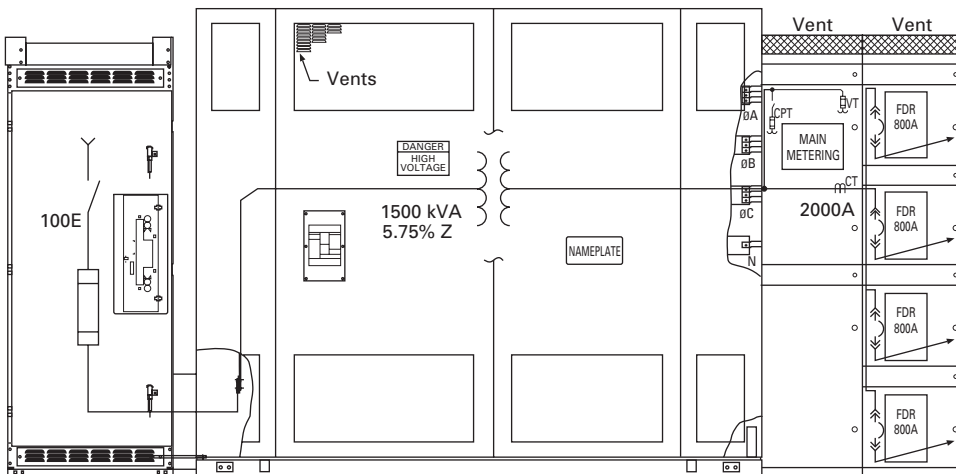
- Arcflash Reduction Maintenance System™ mode
- (ZSI) Zone selective interlocking; see diagram on page 3 for ZSI example



MSB Side View



MSB Front View



Typical unit substation with fused switch primary and no secondary main breaker

Potential arc flash hazard for secondary switchgear bus without MSB

Bus fault at 480V switchgear

- 10 kA secondary arcing fault
- At 13.8 kV = 348A primary fault
- 100E fuse clearing time = 160 seconds

Fault at 480V switchgear bus

- NFPA 70E results
- 31.8 kA symmetrical fault current
- 1167-inch arc flash boundary
- 702.4 cal/cm at 18 inches
- Unapproachable NFPA 70E–2009: Category 4 is highest category at 40 cal/cm**

Reduced arc flash hazard with MSB

Bus fault at 480V switchgear

- 10 kA secondary arcing fault
- At 13.8 kV = 348A primary fault
- 100E fuse clearing time = 160 seconds

- **Using MSB with integral trip unit with ZSI or in Arcflash Reduction Maintenance System mode clears fault in three cycles or less (arcing energy down to Category 2 per NFPA 70E)**

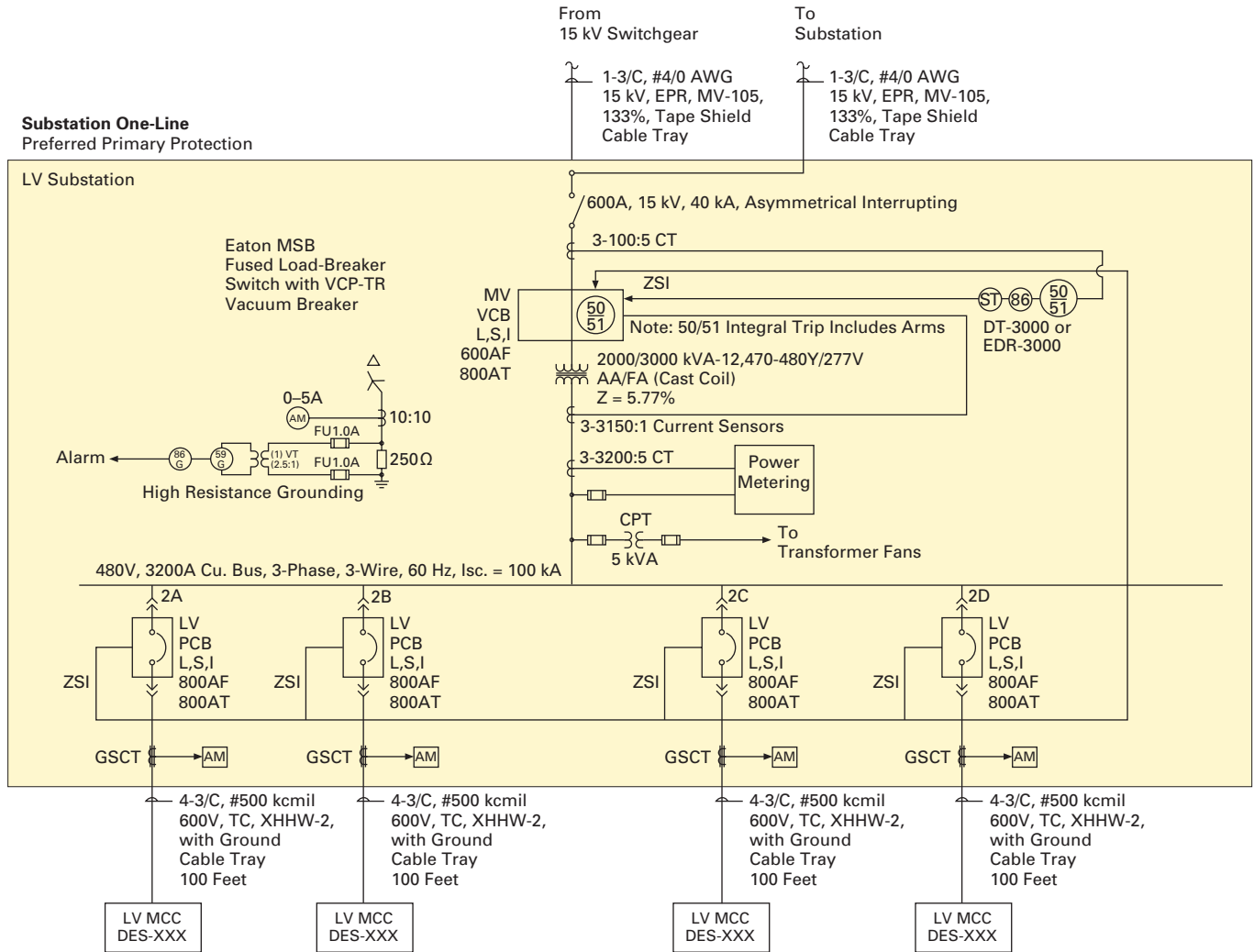


Diagram of substation using MSB with ZSI employed between the primary main breaker and the secondary feeder breakers

Product offering

- Rated maximum voltage: 4.76 to 15 kV
- Rated voltage withstand (BIL): 4.76 kV Class—60 kV peak; 15 kV Class—95 kV peak
- Assembly main bus continuous current: 1200A
- Non-fused and fused switch: refer to type MVS load interrupter switchgear
- Fuse types: current limiting (CLE), expulsion (RBA)
- Breaker types: VCP-TR, VCP-TRL vacuum breakers, fixed

Available configurations

- Main with feeders
- Maintenance tie breaker with feeders
- Main-main with feeders
- Main-main automatic transfer
- Maintenance tie breaker automatic transfer
- Main service disconnect
- Switching and protection of transformers, feeder circuits and capacitor banks
- Capacitor switching

Unique features

- Combination load-break switch and medium voltage vacuum circuit breaker
- Door-mounted DT-3000 50/51 overcurrent protection with integral current transformers
- Integral 50/51 trip unit in a VCP-T primary vacuum breaker with special design current sensors mounted at the secondary bus. Special arc flash reduction maintenance setting to lower incident energy while racking secondary feeder breakers
- Capability for ZSI connection across all Eaton trip units at both primary and secondary

- Special design R-C snubber network to ensure substation transformer is protected from switching transients
- Arcflash Reduction Maintenance System mode available to temporarily reduce the clearing time for the VCP-T breaker during downstream maintenance

Standards

- IEEE® C37.20.3
- IEEE C37.04
- IEEE C37.06
- IEEE C37.09
- CSA® C22.2

Enhanced circuit breaker protection

With the addition of VCP-TR/ VCP-TRL vacuum circuit breakers, MSB is able to provide enhanced system capabilities as follows:

- VCP-TRL breakers use a linear actuator mechanism that is capable of enduring 100,000 operations
- High interrupting capacity suitable for use with ground fault equipment and differential relay schemes
- Adjustable overcurrent protection
- Three-phase tripping, eliminating single phasing
- Eaton's integrally mounted self-powered 520MCV, 1150V trip units and FP-5000 protective relay offer Arcflash Reduction Maintenance System

Available vacuum breaker ratings

VCP-TR Breaker Ratings for Use with MSB (ANSI C37.04 UL®-Recognized Component)

Circuit Breaker Type ①	Rated Values								
	Rated Maximum Voltage (V)	Insulation Level			Continuous Current	Short Circuit Breaking Current ②	Short Circuit Making Current	Mechanical Endurance C-O	Approx. Weight
		Power Frequency	Impulse Withstand	Amperes					
kV rms	kV rms	kV Peak	Amperes	kA rms	kA Peak	Operations	Lbs		
50 VCP-TR16	4.76	19	60	600, 1200	16	42	10,000	157, 159	
50 VCP-TR20	4.76	19	60	600, 1200	20	52	—	163, 165	
150 VCP-TR25	4.76	19	60	600, 1200	25	65	10,000	169, 171	
150 VCP-TR16	15	36	95	600, 1200	16	42	10,000	159, 161	
50 VCP-TR20	15	19	95	600, 1200	20	52	10,000	165, 167	
150 VCP-TR25	15	36	95	600, 1200	25	65	10,000	171, 173	
50 VCP-TR20	4.76	19	60	600, 1200	40	104	10,000	334, 334	
150 VCP-TR25	15	36	95	600, 1200	40	104	10,000	338, 338	

① Independent shunt trips are available for use with traditional protective relaying schemes.

② Also two-second short time current rating.

VCP-TRL Breaker Ratings for Use with MSB (ANSI C37.04 and C37.09 UL-Recognized Components)

Circuit Breaker Type ①	Rated Values								
	Rated Maximum Voltage (V)	Insulation Level			Continuous Current	Short Circuit Breaking Current ②	Short Circuit Making Current	Mechanical Endurance C-O ③	Approx. Weight
		Power Frequency	Impulse Withstand	Amperes					
kV rms	kV rms	kV Peak	Amperes	kA rms	kA Peak	Operations	Lbs		
50 VCP-TRL16	4.76	19	60	600, 1200	16	42	100,000	153, 155	
50 VCP-TRL20	4.76	19	60	600, 1200	20	52	—	159, 161	
150 VCP-TRL25	4.76	19	60	600, 1200	25	65	100,000	166, 168	
150 VCP-TRL16	15	36	95	600, 1200	16	42	100,000	156, 157	
50 VCP-TRL20	15	36	95	600, 1200	20	52	100,000	161, 163	
150 VCP-TRL25	15	36	95	600, 1200	25	65	100,000	168, 170	

① Independent shunt trips are available for use with traditional protective relaying schemes.

② Also two-second short time current rating.

③ Operating mechanism up to 100,000 operations, vacuum interrupter 30,000.

Optional VCP-TRL Breakers with Capacitors Switching Capabilities

Circuit Breaker Type	Single Bank	Back-to-Back	Cable Charging
Optional "C" type versions available in rating shown in above rating table	250A and 1000A	250A and 630A	25A

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