SEATTLE ELECTRICAL LEAGUE SEPTEMBER 16TH, 2020

NEC 240.67 Arc Energy Reduction

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Arc Energy Reduction - Agenda

- History of requirements
- Required documentation
- Determining if arc energy reduction is needed
- Approved methods of arc energy reduction
- Performance testing of arc energy reduction protection systems

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History

Arc Energy Reduction - History

- Began with concern for delayed tripping of circuit breakers and NEC 240.87
- 2011 - CBs without instantaneous trip (power circuit breakers) with three options: zone selective interlocking, differential relaying or energy-reducing maintenance switching with local status indicator
- 2014 – All 1200A or larger circuit breakers (power and molded case circuit breakers) and added energy-reducing active arc flash mitigation system and approved equivalent means
- 2017 – Added use of instantaneous trip/override setting that is less than the available arcing current (and information notes) as another method to address arc energy reduction

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Arc Energy Reduction - History

- Moved to fuse technology in the 2017 NEC with addition of NEC 240.67
- An effective date (1/1/2020) was established to give manufacturers an opportunity to create product
- Additional changes in NEC 2020 (in both 240.67 and 240.87)
- Note – applies NOW for jurisdictions that have adopted the 2017 NEC

Documentation

240.67 Arc Energy Reduction

240.67 Arc Energy Reduction.

Where fuses rated 1200 A or higher are installed, 240.67(A) and (B) shall apply. This requirement shall become effective January 1, 2020.

(A) Documentation.

Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the fuses.

<u>Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arcing current.</u>

Red underlined text indicates NEC 2020 change

Documentation

- Location
  - Single-line diagrams that identify all 1200A fuses is an effective way to document the location of the fuses.
- Operation at arcing current (per NEC 2020)
  - Documentation can vary based upon method used.
  - Can include available fault current and arcing current calculations and time-current curves.
  - Can include use of programs such as SKM, Easy Power or Manufacturer tools
  - If other technology is required, consult equipment manufacturer.

Determining if arc energy reduction is needed

240.67 Arc Energy Reduction

240.67 Arc Energy Reduction.

Where fuses rated 1200 A or higher are installed, 240.67(A) and (B) shall apply. This requirement shall become effective January 1, 2020. Brnch, Feered or Main OCPD, No mention of voltage.

(B) Method to Reduce Clearing Time.

A fuse shall have a clearing time of 0.07 seconds or less at the available arcing current, **OR** one of the following means shall be provided and shall be set to operate at less than the available arcing current:

(1) Differential relaying

(2) Energy-reducing maintenance switching with local status indicator

(3) Energy-reducing active arc-flash mitigation system

(4) Current-limiting, electronically actuated fuses

(5) An approved equivalent means

Informational Notes Apply

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IS arc reduction technology required?

- Not required for fuses rated below 1200A (e.g. A 1000A fuse in a 1200A switch does not have to comply)
- Not all fuses 1200A and above will have to have an arc energy reduction methods applied.
- ONLY fuse 1200A and above with a clearing time longer than 0.07 seconds at the arcing current
- Determining if arc energy reduction is required involves
  - Calculate the available fault current
  - Calculate the arcing current
  - Consult the fuse time-current curve

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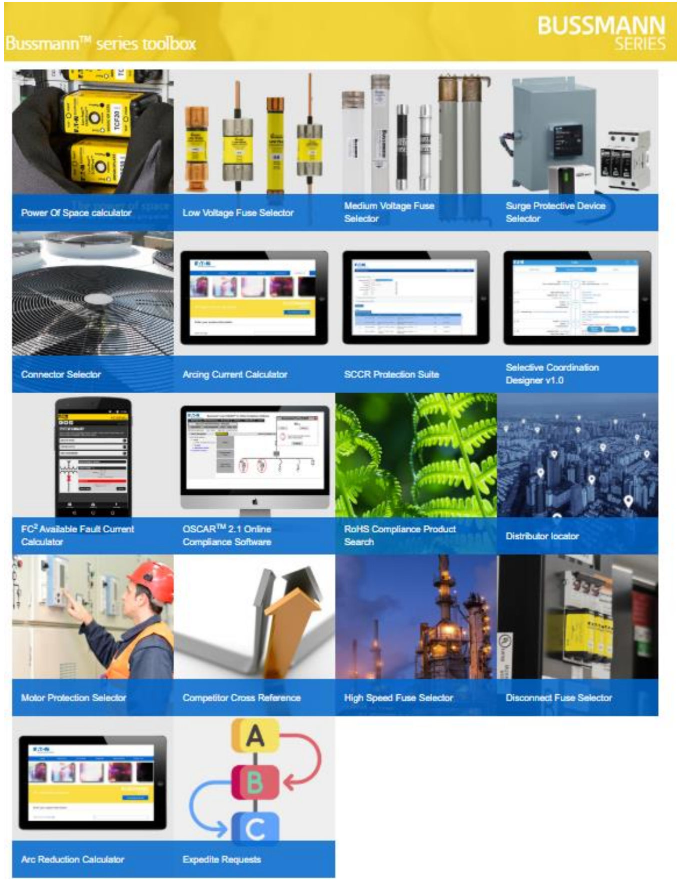
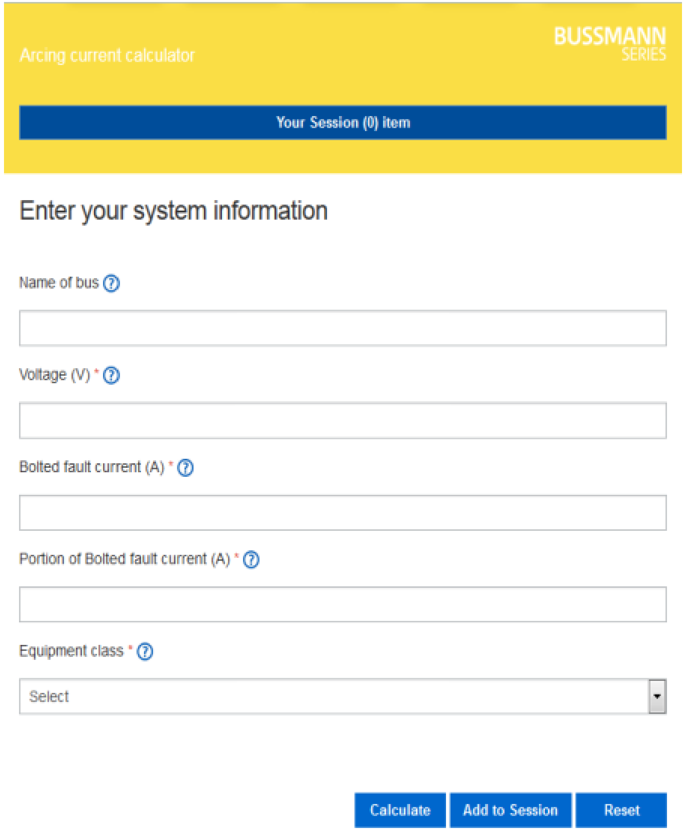
Resources and tools

- Bussmann series toolbox
- https://toolbox.bussmann.com/
  - Available fault current calculator (FC^2)
  - Arcing Current Calculator
  - Arc Reduction Calculator
  - Many more!



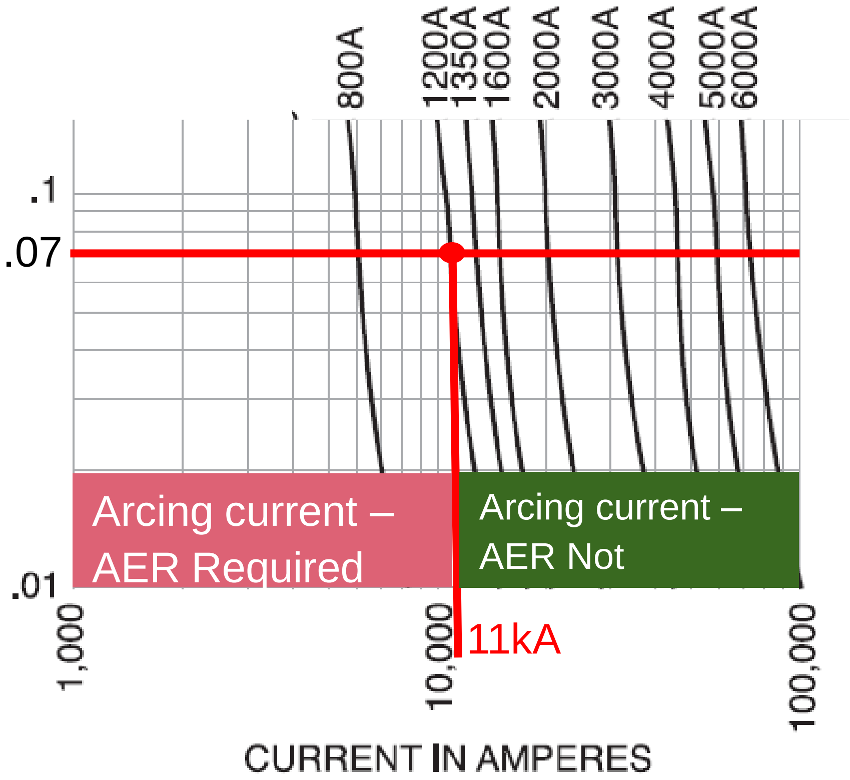
Arcing Current

- Arcing current calculator
- Voltage = 480V
- Bolted fault current (A) = 35,000
- Portion of bolted fault current (A) = 35,000
- MCC & Panels
- Arcing Current = 19,120 A
- Arcing Current (85%) = 16,250 A



Time Current Curve

- Compare to time current curve
- Arc energy reduction not required for arcing currents equal or greater than this value
- In this case, arc energy reduction is not required since the arcing current is 16,250A



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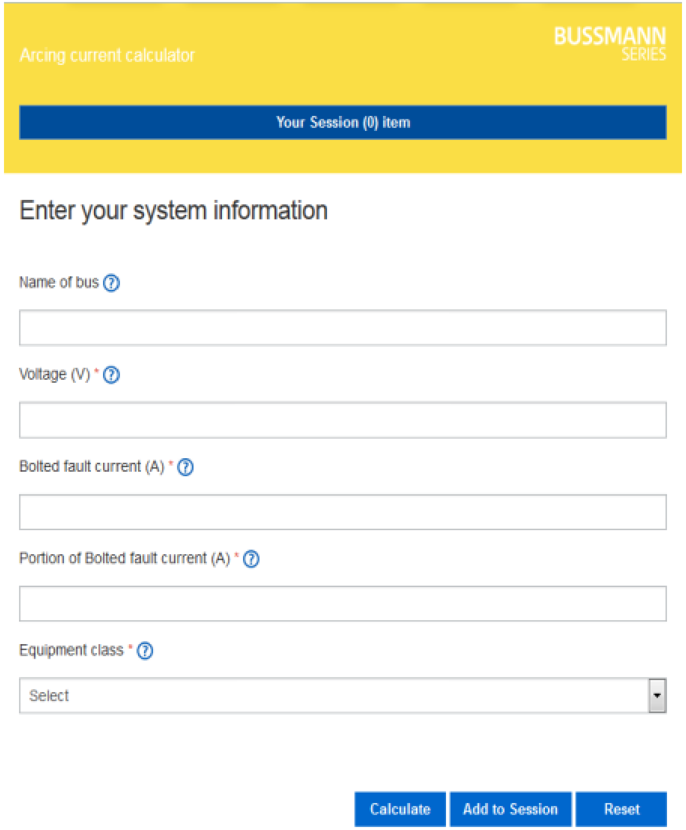
Arcing Current

- Arcing current calculator
- Voltage = 208V
- Bolted fault current (A) = 35,000
- Portion of bolted fault current (A) = 35,000
- MCC & Panels
- Arcing Current = 10,480 A
- Arcing Current (85%) = 8,910 A

- NOTE – Currently does NOT use IEEE 1584-2018



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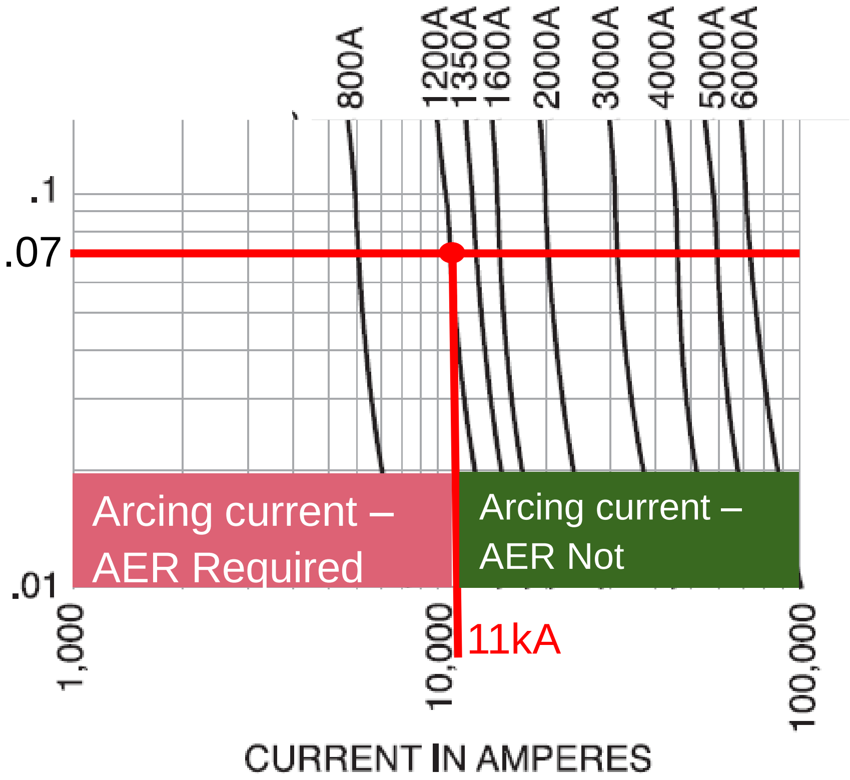
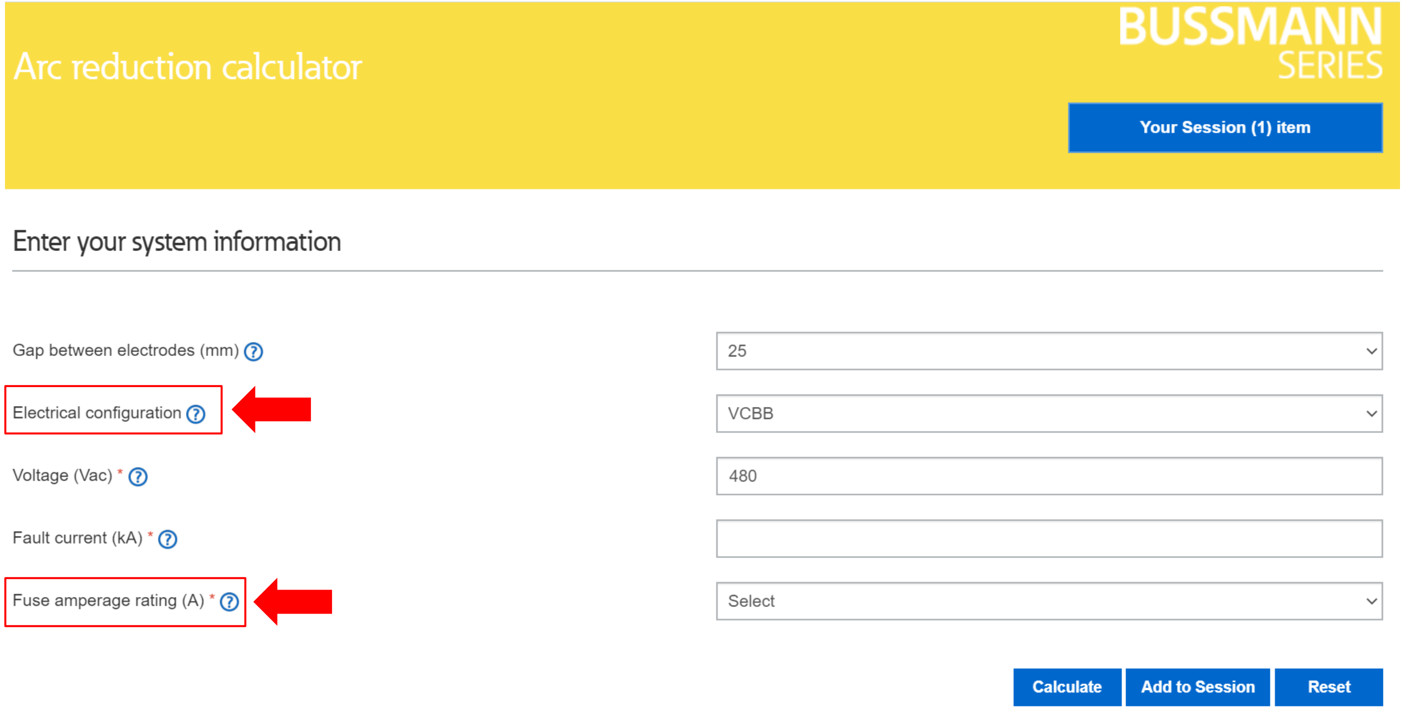
Time Current Curve

- Compare to time current curve
- Arc energy reduction not required for arcing currents equal or greater than this value
- In this case, arc energy reduction is required since the arcing current is 8,910A



Resources: NEW Arc Energy Reduction Calculator

- https://arc.bussmann.com/
- Based on IEEE 1584-2018



Selection Parameters

- Fault Current (kA)
  - Value between 0.5kA and 106kA
  - If fault current is above 106kA, use 106kA since no methods of arcing current calculations are available
- Fuse Ampacity Rating
  - Maximum fuse ampacity of 2500A, above 2500A arc energy reduction is required.

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Your Session Items

- Remove from Sesssion list

Gap between electrodes (mm)	25	
Electrical configuration	VCBB	
Voltage (Vac)	480	
Fault current (kA)	35	
Fuse amperage rating (A)	1200	
Results		Per 1EEE 1584-2002
Max arcing current (kA)	27.52	19,120 A
Min arcing current (kA)	24.26	16,250 A

<u>Below listed are the available fuses on 1200A:</u>

KRP-C-1200	PASS	Pass
KTU-1200	PASS	Pass

- Note: Arcing current is higher than previous calculation per previous edition of IEEE 1584

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240.67 Arc Energy Reduction

Your Session Items

- Remove from Sesssion list

Gap between electrodes (mm)	25	
Electrical configuration	VCBB	
Voltage (Vac)	208	
Fault current (kA)	35	
Fuse amperage rating (A)	1200	
Results		Per 1EEE 1584-2002
Max arcing current (kA)	16.9	10,480 A
Min arcing current (kA)	14.46	8,910 A

Below listed are the available fuses on 1200A:

KRP-C-1200	PASS	Fail
KTU-1200	PASS	Fail

- Note: Arcing current is higher than previous calculation per previous edition of IEEE 1584

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Approved methods of arc energy reduction

240.67 Arc Energy Reduction

240.67 Arc Energy Reduction.

Where fuses rated 1200 A or higher are installed, 240.67(A) and (B) shall apply. This requirement shall become effective January 1, 2020.

(B) Method to Reduce Clearing Time.

A fuse shall have a clearing time of 0.07 seconds or less at the available arcing current, or one of the following means shall be provided and shall be set to operate at less than the available arcing current:

(1) Differential relaying

(2) Energy-reducing maintenance switching with local status indicator

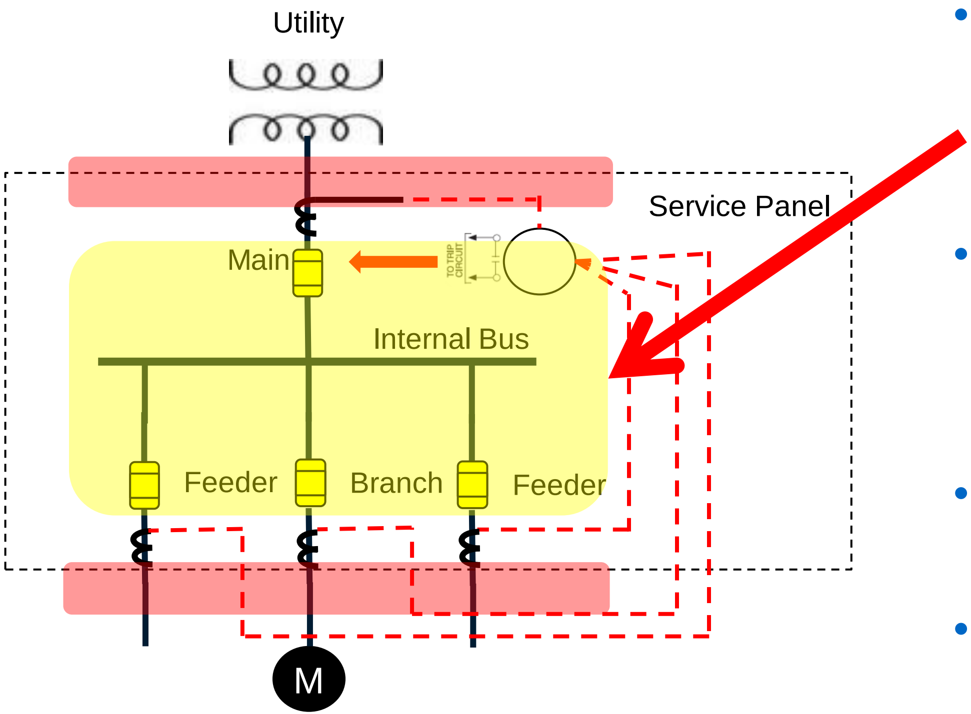
(3) Energy-reducing active arc-flash mitigation system

(4) Current-limiting, electronically actuated fuses

(5) An approved equivalent means

Red underlined text indicates NEC 2020 change

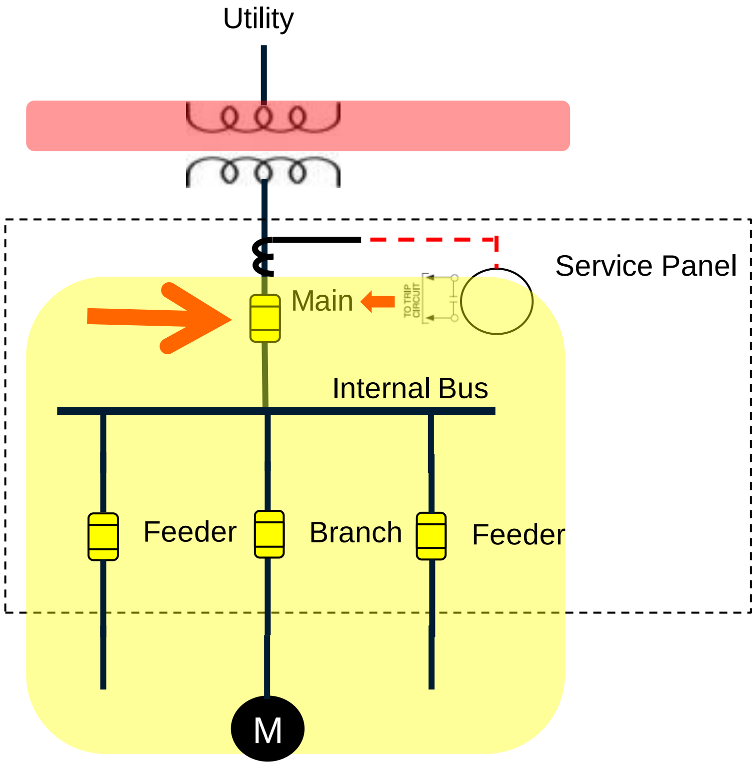
(1) Differential relaying



- These are the zones (yellow) of protection offered by a differential relaying system (ST secondary)
- Fault outside zone (red) will not activate system since no difference in current going through CTs
- Requires shunt trip switch that is rated to open the arcing current
- Typically most expensive option

(2) Energy-reducing maintenance switching with local status indicator

- These are the zones of protection (yellow) offered by a energy-reducing maintenance switch
- This fused switch equipped with an energy reduction maintenance switch provides protection for downstream faults greater than its pickup value of current
- Requires bolted pressure switch based on power circuit breaker design with energy reducing maintenance switch



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(2) Energy-reducing maintenance switching with local status indicator

- Example – GE HPC with RELT (Reduced Energy Let Through)

(2) Energy-reducing maintenance switching with local status indicator

Example – Eaton shunt trip switch with AER relay

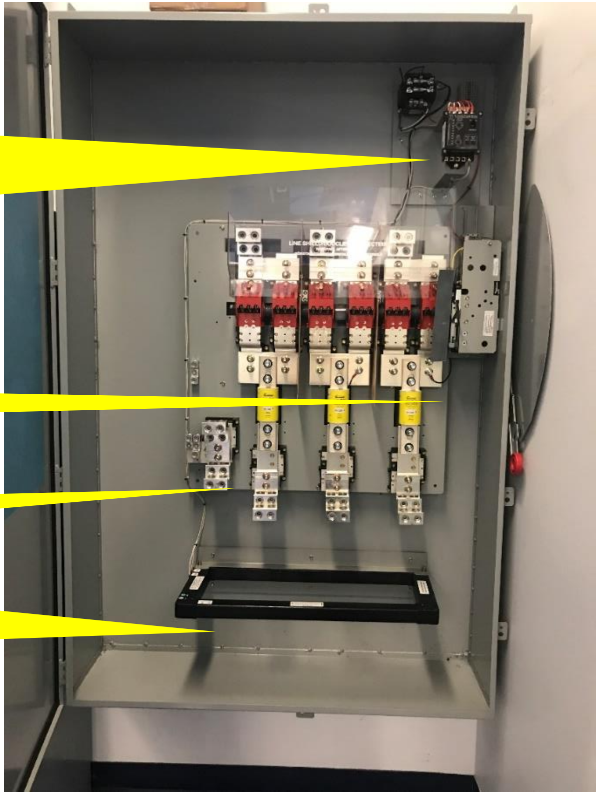
GF protection, overcurrent protection (long time trip settings and above 600% - 0.05 sec clearing), and maintenance mode (ARMs - 2.5X switch rating)

Shunt trip switch

1200A Fuses

Zero sequence CTs

(change to phase/neutral CTs)



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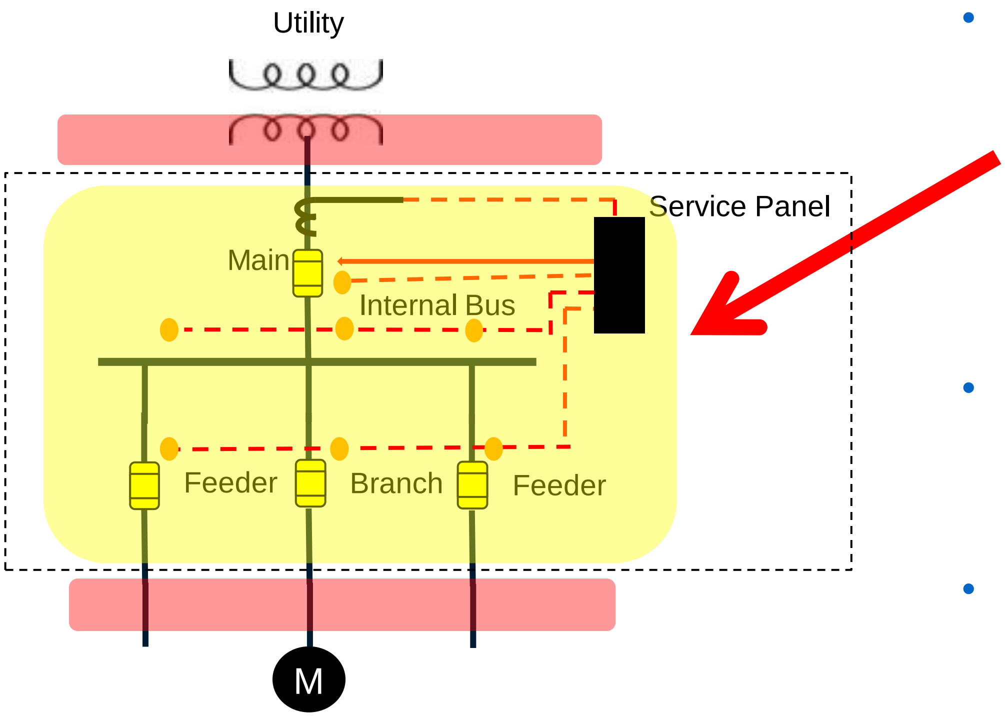
(3) Energy-reducing active arc flash mitigation system – arc flash relay and light sensor(s)



- Faults within this zone (Within the enclosure) are cleared without an intentional delay as long as they are greater than the pickup point of the arc flash relay and activation of a light sensor)
- Fault outside zone (red) will not activate system since there is no activation of light sensors
- Requires shunt trip switch that is rated to open the arcing current and arc flash relay and associated components or arc quenching device

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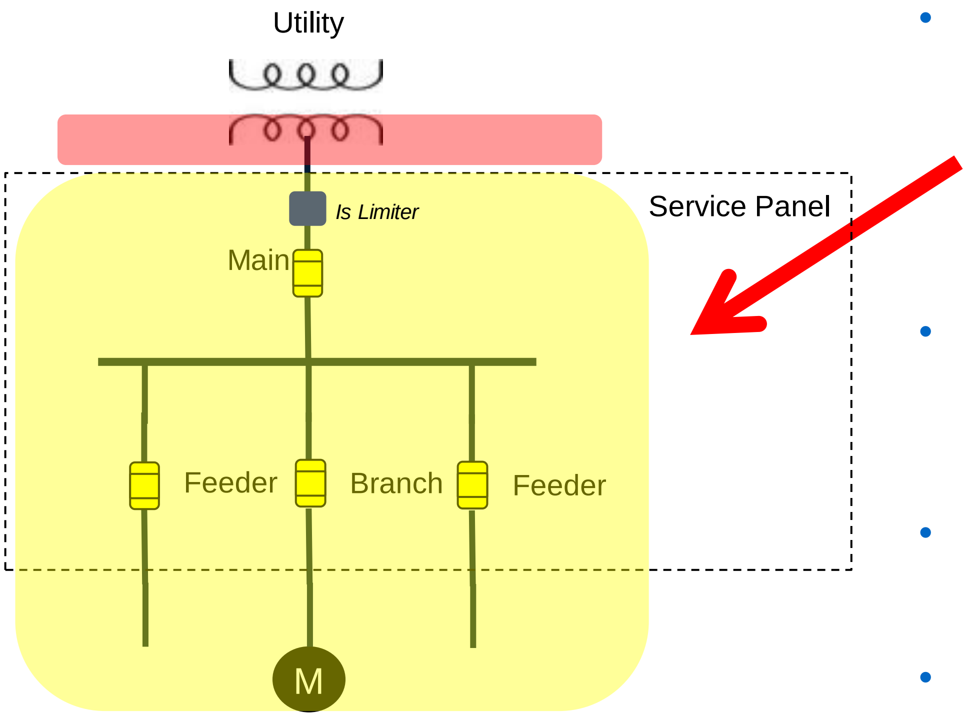
(3) Energy-reducing active arc flash mitigation system – Is limiter



- Faults within this zone (Within the enclosure) are cleared without an intentional delay as long as they are greater than the pickup point of the Is Limiter
- Fault outside zone (red) will not activate system since it is ahead of the arc flash mitigation system
- Operates only based on current (not light sensors) and can be remotely disabled
- Requires replacement of parts after operation (interrupter and CL fuse)

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(3) Energy-reducing active arc flash mitigation system

Example – *G&W Electric's CLiP®-LV*

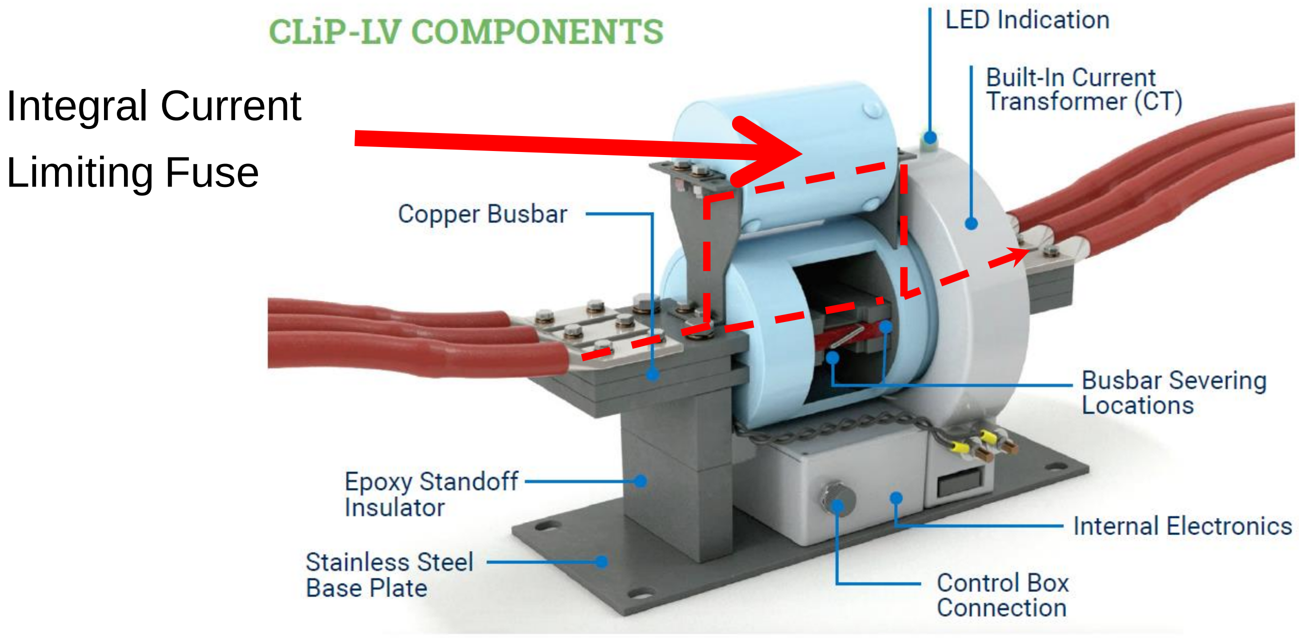

Figure 1: G&W Electric's CLiP®-LV

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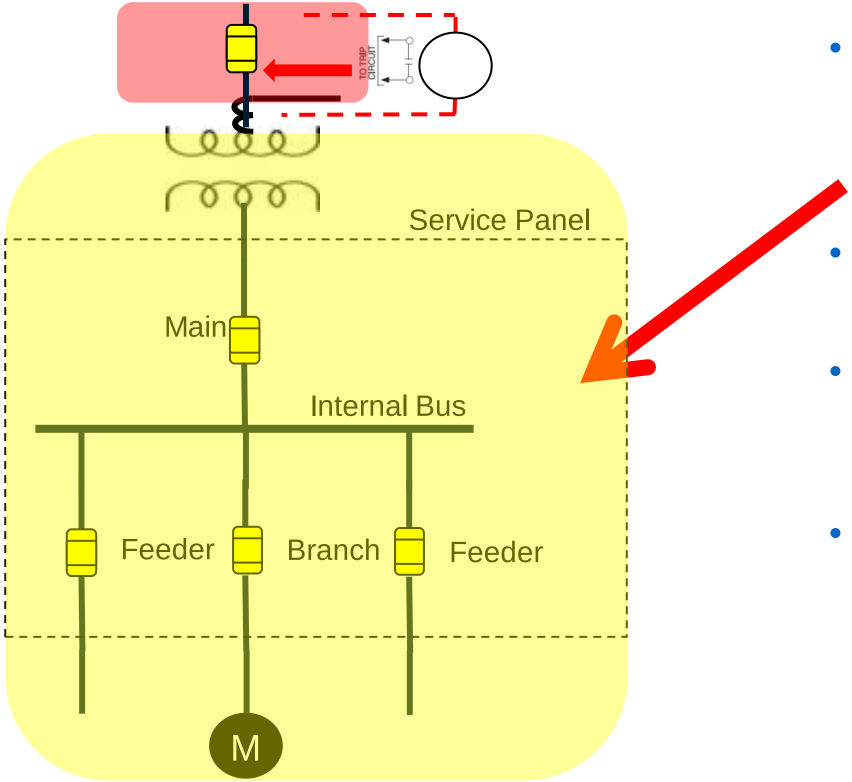
(4) Current-limiting, electronically actuated fuses



- Faults within this zone are cleared without an intentional delay as long as they are greater than the pickup point of the relay that triggers the opening of the fuse
- Present technology finds this fuse on the MV side of the transformer
- The electronically actuated fuse would be designed to operate under lower values of currents or activated via a relay
- Commercially available units operate based on electronically preselected trip curve not based upon CT and selected trip point on relay to trigger opening fuse.

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(4) Current-limiting, electronically actuated fuses

- Definition: NEC Article 100
- Electronically Actuated Fuse.
  An overcurrent protective device that generally consists of a control module that provides current sensing, electronically derived time–current characteristics, energy to initiate tripping, and an interrupting module that interrupts current when an overcurrent occurs. Electronically actuated fuses may or may not operate in a current-limiting fashion, depending on the type of control selected. (CMP-10)
- Permitted method per 2020 NEC

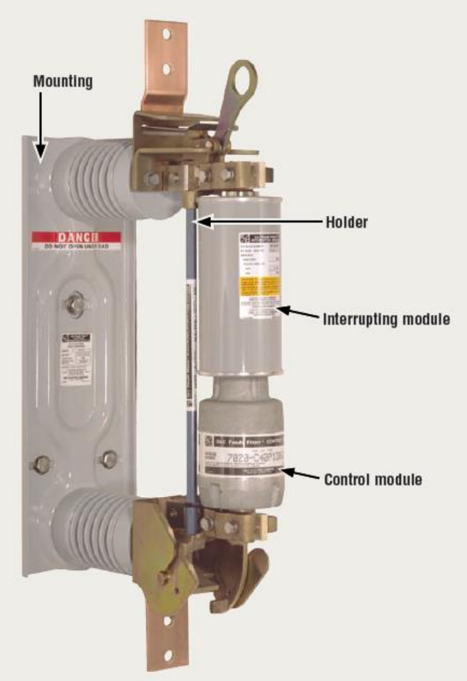

Figure 8. S&C Fault Fiter Electronic Power Fuse (600-ampere Disconnect Style Mounting shown).

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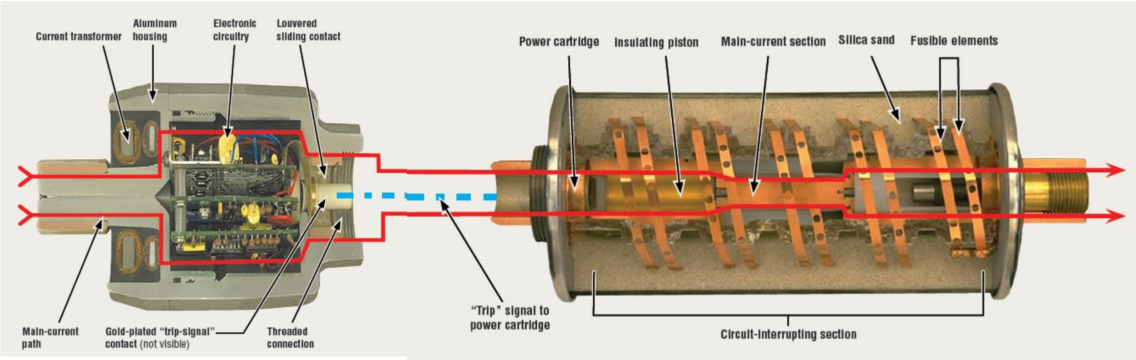
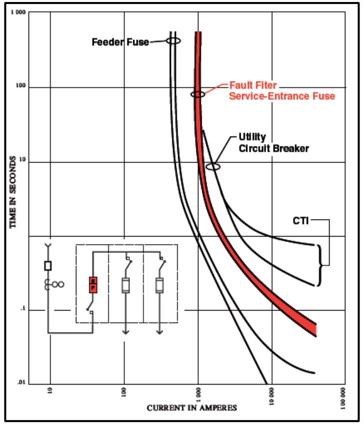
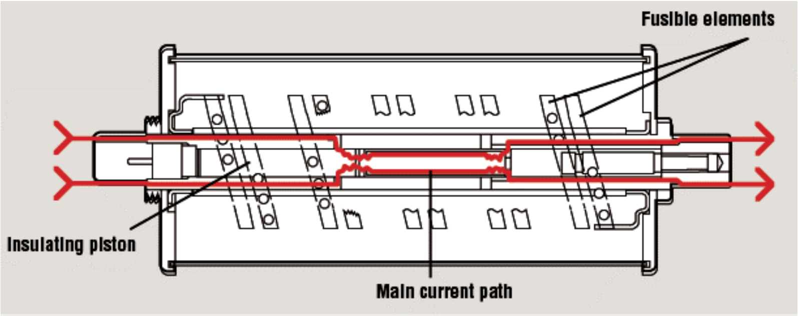
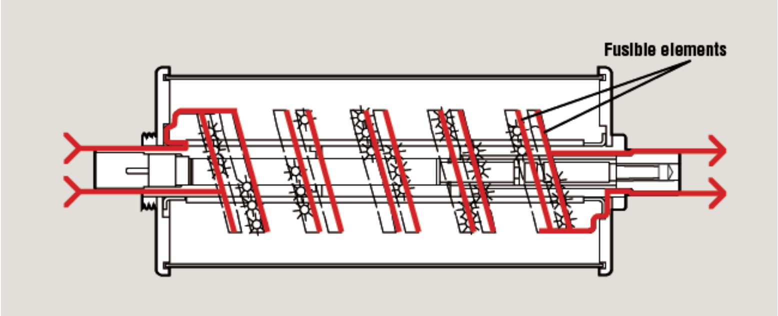
(4) Current-limiting, electronically actuated fuses









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Performance testing of arc energy reduction protection systems

240.67 Arc Energy Reduction

240.67 Arc Energy Reduction.

Where fuses rated 1200 A or higher are installed, 240.67(A) and (B) shall apply. This requirement shall become effective January 1, 2020.

(C) Performance Testing.

~~Where a method to reduce clearing time is required in 240.67(B), the~~The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer's instructions.

~~Performance testing of an instantaneous element of the protective device shall be conducted by a qualified person(s) using a test process of primary current injection and the manufacturer's recommended test procedures.~~

A written record of this testing shall be made and shall be available to the authority having jurisdiction.

Informational Note: Some energy reduction protection systems cannot be tested using a test process of primary current injection due to either the protection method being damaged such as with the use of fuse technology or because current is not the primary method of arc detection.

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NEW for NEC 2020 - red text indicates TIA change

Performance Testing

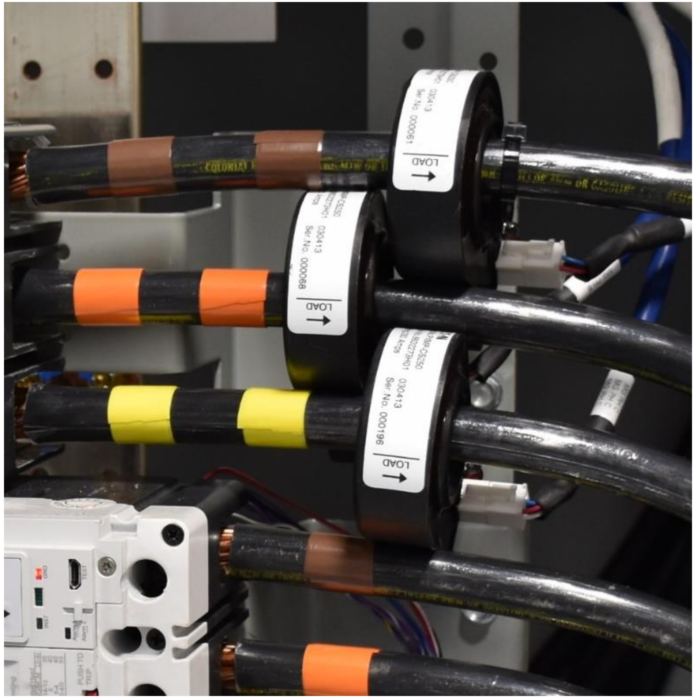
- Similar requirements to NEC 230.95 GFPE
- Manufacturer instructions are very important because some arc reduction technologies are destructive to the technology themselves.
- Documentation of performance testing is required and important for the AHJ and the customer for future reference beyond initial installation.
- Primary current injection is not required where it could damage the arc energy reduction method used such as fuses and arc quenching devices
- Only qualified individuals who understand the technologies employed should perform testing.

Performance testing – Critical components

- CT's – all solutions will employ CTs polarity of which must be checked (External / Internal)
- Electronics – ensure electronics are functioning
- Sensors – some technologies may include other types of sensors, communication with those sensors must be checked
- Test system to assure proper installation and connections per manufacturer's instructions

CT testing

- Ratio test (tests via current or voltage to confirm CT ratio)
- Polarity test (direction of current)
- Excitation (Saturation) test (point where current can no longer be provided at the CT ratio)
- Insulation resistance test (dielectric test of CT)
- Winding resistance test (tests accuracy of CT)
- Burden test (verify that CT is supplying current that does not exceed its burden rating)
- Verify relay class (% accuracy, CT class, maximum burden) for application



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Primary current injection testing

- Primary current injection testing of a fusible switch is possible to perform (at low current levels) to test CT polarity and electronics.
- Test equipment exists that may already be used for GFPE testing
- Always follow test equipment manufacturer instructions to conduct testing

Documentation

- A complete record of tests should be documented
- All tools and manufacturer documents should also be included
- Time, date, and signed
- Professional should be qualified and experienced with the specific manufacturer equipment

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Review and questions

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