Welcome

Review of NEC Article 240.87

ARC ENERGY REDUCTION

WHY ?

The idea behind arc-energy reduction is to place the energized electrical equipment in a state where there will be less arc-energy in the event that an accident occurs while the servicing electrician is working in the live gear.

REQUIREMENT

240.87 Arc Energy Reduction

"Where the highest continuous current trip setting for which the actual overcurrent device is installed in a circuit breaker is rated, **or can be adjusted**, is 1200A or higher, 240.87(A) and 240.87(B) shall apply."

Let's look at these paragraphs.

240.87(A)

Documentation

“Documentation shall be available to those authorized to design, install, operate or inspect the installation as to the location of the circuit breaker(s). 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.”

What does this mean….

240.87(A)

Documentation

As an example, after a short circuit study is performed, if the available short circuit current (available arcing current) is 35,000A RMS, then the circuit breaker must be able to be set to initiate circuit interruption at a value below 35,000A RMS

240.87(B)

Method to Reduce Clearing Time

"One of the following means shall be provided and shall be set to operate at less than the available arcing current."

(1) Zone-selective interlocking
(2) Differential relaying
(3) Energy-reducing maintenance switching with local status indicator
(4) Energy-reducing active arc flash mitigation system
(5) An instantaneous trip setting. Temporary adjustment of the instantaneous trip setting to achieve an arc energy reduction shall **not** be permitted.
(6) An instantaneous override.
(7) An approved equivalent means.

Let's look at each one of these.

240.87(B)

Method to Reduce Clearing Time

(1) Zone-selective interlocking

Zone selective interlocking (ZSI) is an interlocking system used to enhance the selective coordination level of electrical distribution systems. It allows an upstream breaker to trip instantaneously on a fault in its zone while maintaining coordination with downstream breakers. When dealing with two or three breakers, this is a relatively easy task, and easier yet if all the breakers are from the same manufacturer. As the power network increases in breaker numbers, the study and interconnected wiring becomes much more difficult. It also requires a review of the study when breakers are changed, or new breakers added. This solution is considered moderately expensive.

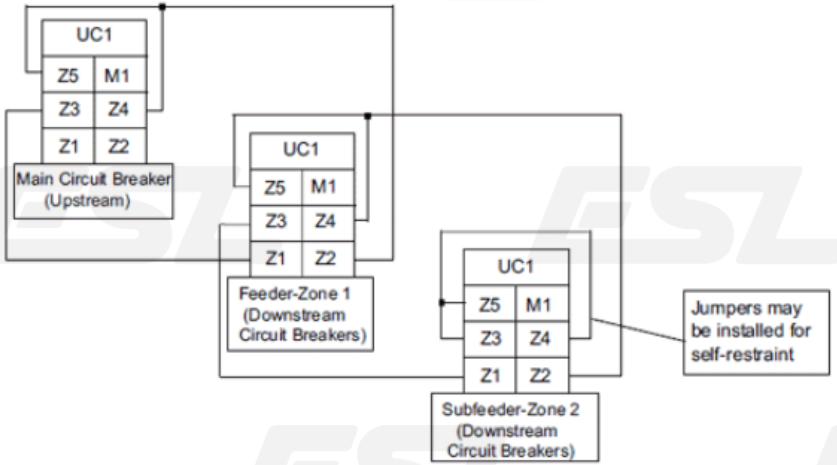
240.87(B)

Method to Reduce Clearing Time

Zone-selective interlocking

Typical ZSI Connections

Secondary Connector Position	Description
Z1	ZSI OUT Signal
Z2	ZSI OUT
Z3	ZSI IN Signal
Z4	ZSI IN Short-time
Z5	ZSI IN Ground-fault

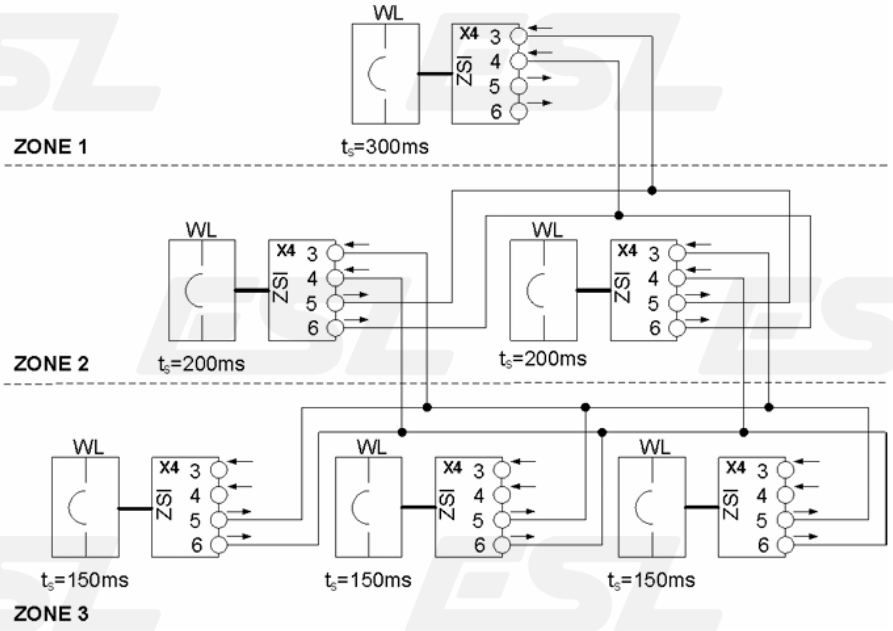


240.87(B)

Method to Reduce Clearing Time

ZONE SELECTIVE INTERLOCKING (ZSI) APPLICATION AND TESTING GUIDE
SIEMENS WL UL489 AND UL1066 AIR CIRCUIT BREAKERS

Zone-selective interlocking



240.87(B)

Method to Reduce Clearing Time

(2) Differential relaying

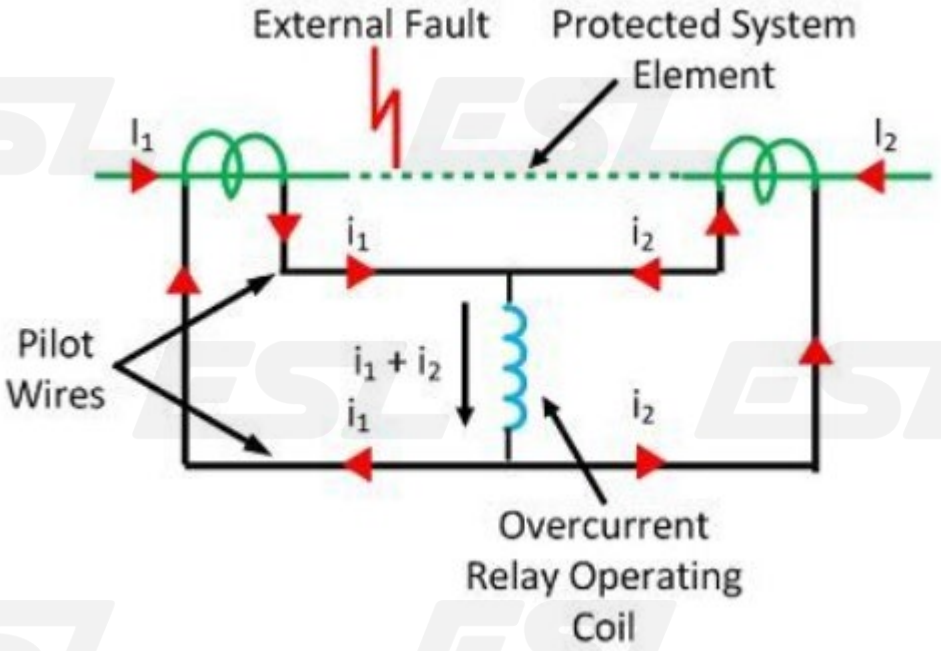
As the name suggests, this solution relies on relays monitoring the electrical values at various points in the system. If the “values” are not equal (within a pre-set limit) between measuring points, the relay will trip the connected breakers. This solution is expensive and therefore usually only found in critical systems. There are typically (3) methods to accomplish this:

- Current Differential Relay
- Biased or Percentage Differential Relay
- Voltage Balance Differential Relay

240.87(B)

Method to Reduce Clearing Time

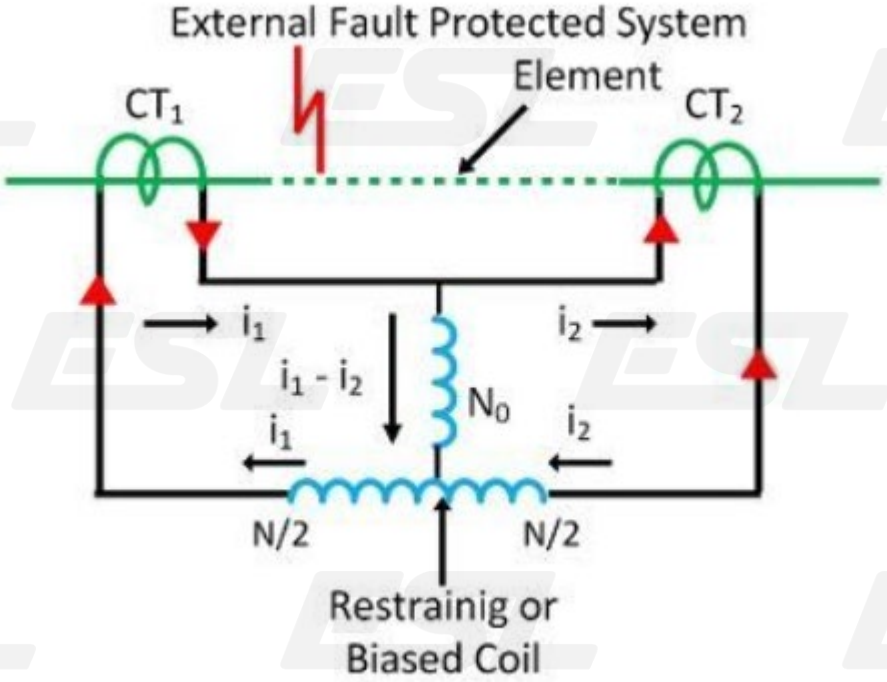
Current Differential relaying



240.87(B)

Method to Reduce Clearing Time

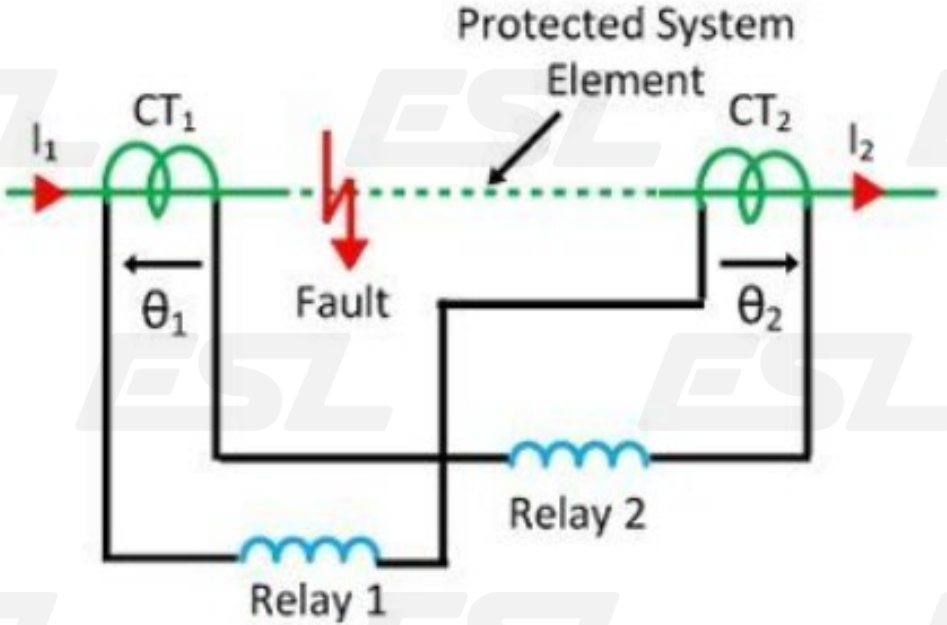
Biased or Percentage Differential Relay



240.87(B)

Method to Reduce Clearing Time

Voltage Balance Differential Relay



240.87(B)

Method to Reduce Clearing Time

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

Maintenance switching with local status indication generally involves a physical switch and light installed on a piece of equipment. If personnel are going to work on a piece of equipment that is energized, they would toggle the switch, which would send a signal to the next upstream overcurrent protective device to lower its instantaneous settings to minimum. This allows for a system to maintain coordination under normal operating conditions while also limiting arc hazards to personnel during maintenance or other activities.

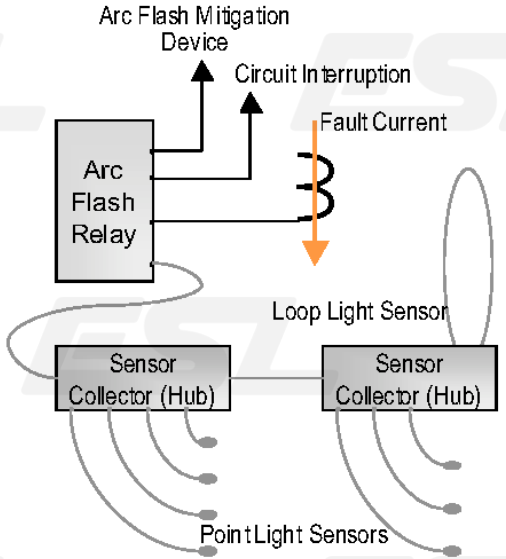
240.87(B)

Method to Reduce Clearing Time

(4) Energy-reducing active arc flash mitigation system

Multiple types of energy-reducing active arc flash mitigation systems exist. One of the most common is an arc flash relay system, which normally uses both light sensors and overcurrent pickup to detect an arc flash event and isolate the equipment. These systems have been around for over a decade and can generally be installed in both new and existing equipment. There are other types of arc flash mitigation systems, namely:

- UltraFast Earthing Switch, which introduces a controlled three-phase line-to-ground fault when sensing arc fault conditions.
- Arc-quenching, which introduces current-limiting devices to control and redirect the fault current.

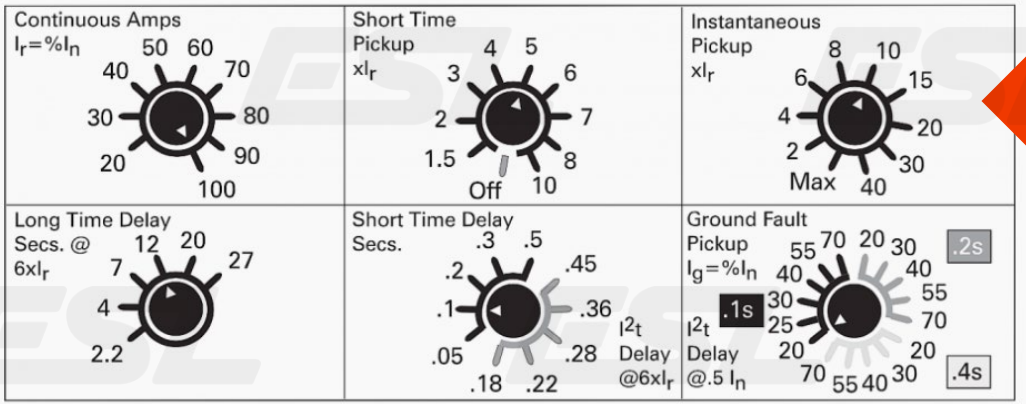


240.87(B)

Method to Reduce Clearing Time

(5) An instantaneous trip setting. Temporary adjustment of the instantaneous trip setting to achieve an arc energy reduction shall not be permitted.

This method allows the use of the adjustable instantaneous trip setting as a “permanent” setting. It is not allowed to be adjusted as a method to reduce the clearing time.



240.87(B)

Method to Reduce Clearing Time

(6) An instantaneous override.

Most manufacturers have breakers with non-adjustable instantaneous trip override. The key is to select a breaker with this non-adjustable setting that is below the minimum possible arcing fault current. If the instantaneous trip setting is too low, selective coordination may not be achievable with some electrical systems.

240.87(B)

Method to Reduce Clearing Time

(7) An approved equivalent means.

This is obviously difficult to define. The biggest obstacle is who will approve the “equivalent” means, and can you get approval during the design stage? ESL believes there are times/situations when arc energy reduction may not be required. Rick Traver will talk about this a little more later in his presentation.

240.87(C)

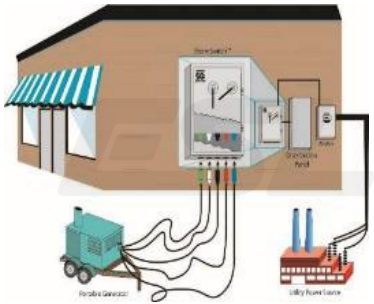
Performance Testing

"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.

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

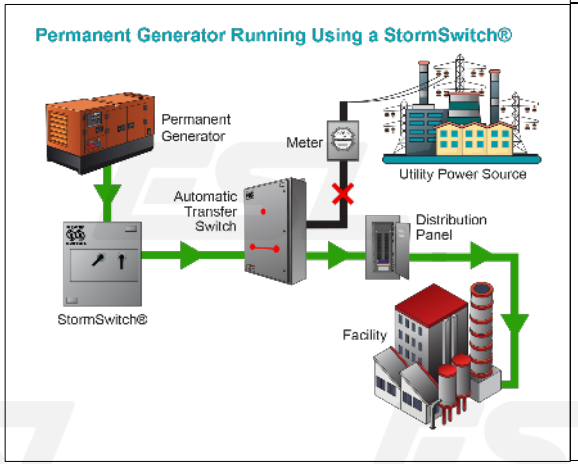
Note: Some systems may not allow for primary current injection due to the risk of component damage such as the use of fuse technology or because current is not the primary method of arc detection.

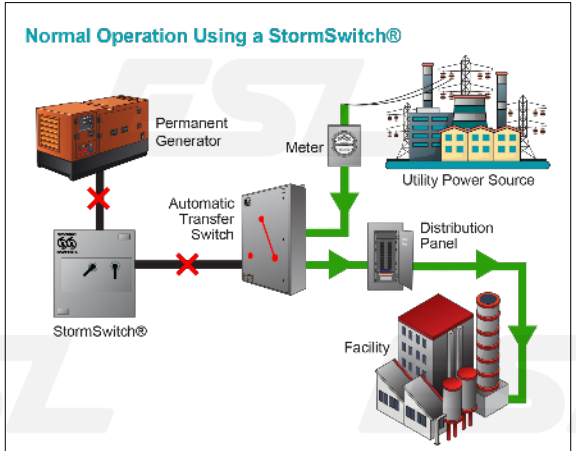
StormSwitch
APPLICATIONS

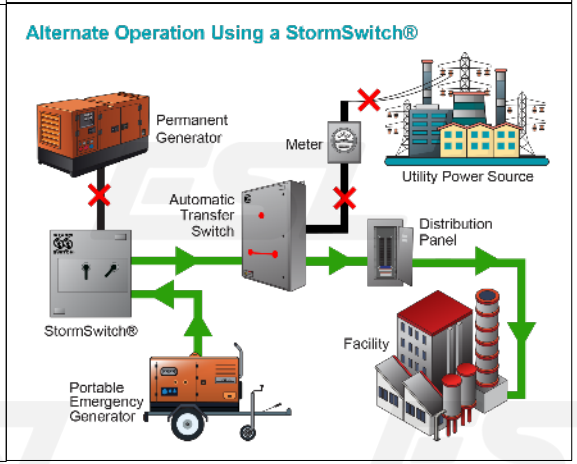


Utility & Portable Generator
Arch-Flash Probably Required

Permanent to Portable Generator
Arch Flash Probably Not Required



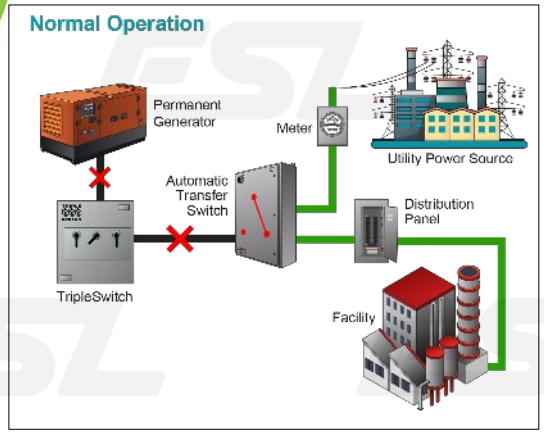




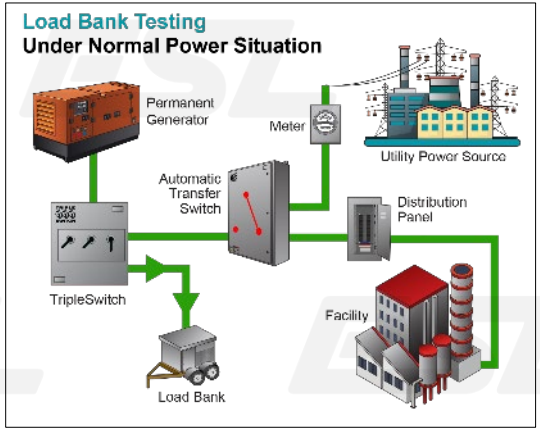
TripleSwitch

APPLICATIONS

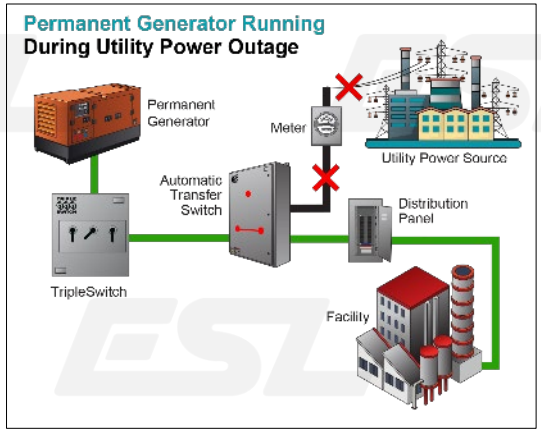
Normal Operation



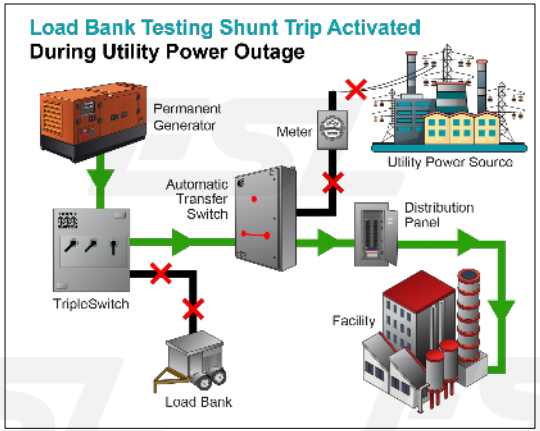
Load Bank Testing
Under Normal Power Situation



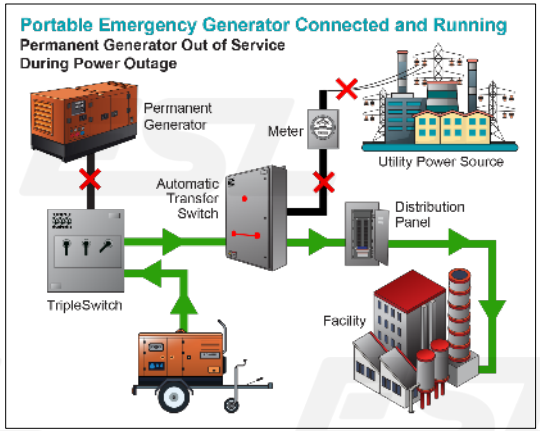
Permanent Generator Running
During Utility Power Outage



Load Bank Testing Shunt Trip Activated
During Utility Power Outage



Portable Emergency Generator Connected and Running
Permanent Generator Out of Service
During Power Outage



Q&A

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ESL POWER SYSTEMS
AN EMPLOYEE OWNED COMPANY