

# 2014 NATIONAL ELECTRICAL CODE®

Changes in Overcurrent  
and Surge Protection

REFERENCE GUIDE



**MERSEN**  
Ferraz Shawmut is Mersen

# Selected 2014 NEC Code Changes in Overcurrent and Surge Protection

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The recommendations by Mersen in this publication are intended to be in compliance with the 2014 NEC, however jurisdictions that adopt the code are solely responsible for any modifications and interpretations to be enforced by their jurisdictions.

The user of the code should identify what regulatory authority has responsibility for the installation approval and always comply with any regulatory authority modifications to the N.E.C. Mersen cannot be responsible for errors and omissions.

# 1. New Arc Flash Circuit Breaker Requirements for 1200A or more

## PREVIOUS CODE REQUIREMENTS

For the first time in the 2011 code, arc flash danger from circuits supplied by certain types of circuit breakers was recognized. Circuit breakers without an instantaneous trip were required to use an additional method for reducing an arc flash danger.

The Section 240.87 Non-instantaneous Trip in the 2011 code said, “Where a circuit breaker is utilized without an instantaneous trip, one of the following or approved equivalent means shall be provided:

1. Zone-selective interlocking
2. Differential relaying
3. Energy-reducing maintenance switching with local status indicator.”

These alternatives are effective, but costly.



## NEW CODE

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

**(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).

**(B) Method to Reduce Clearing Time.** One of the following or approved equivalent means shall be provided:

- (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 approved equivalent means

**Informational Note No. 1:** An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to “no intentional delay” to reduce the clearing time while the worker is working within an arc-flash boundary as defined in *NFPA 70E-2012, Standard for Electrical Safety in the Workplace*, and then to set the trip unit back to a normal setting after the potentially hazardous work is complete.

**Informational Note No. 2:** An energy-reducing active arc flash mitigation system helps in reducing arcing duration in the electrical distribution system. No change in the circuit breaker or the settings of other devices is required during maintenance when a worker is working within an arc flash boundary as defined in *NFPA 70E-2012, Standard for Electrical Safety in the Workplace*.

# 1. New Arc Flash Circuit Breaker Requirements for 1200A or more, *Continued*

## REASONS FOR CHANGES

Many systems were completely designed using only instantaneous trip circuit breakers. That complied with the code, but was not making use of available safer technology.

The new code requires safer technology to be used for any circuit using a circuit breaker that can be set at 1200 amps or more. This does not apply to circuits with fuses 1200 amps or larger.

## HOW TO COMPLY

Every large circuit is more likely to have higher, more hazardous levels of arc flash danger. Select an effective design option that is the most cost-effective for the large circuits. Zone-selective interlocking requires upstream circuit breakers to have a communications channel to the downstream unit. Differential relaying can be complex for commissioning and use. Energy reducing maintenance switches and active arc flash control often require expensive solid-state trip circuit breakers. Electrical inspectors seldom approve other methods because of their potential liability. A possible cost-effective solution is to design in fusible protection instead of circuit breakers.

## HELPFUL PRODUCTS

The Amp-Trap 2000® family delivers current limiting fuses that can reduce costs and reduce arc flash danger to a minimum when the available fault current is adequate. This is frequently more economical than other solutions.

The Amp-Trap 2000 Class L 1200 amp fuse can limit the arc flash danger. For example, the Mersen A4BQ1200 fuse with available bolted fault current at 24,000 amps at 600 volts, will limit the arc flash incident energy to 3.8 cal/cm<sup>2</sup> at a 24 inch working distance. In this example the fuse reduces the PPE required down to Hazard Risk Category 1. In higher available fault current applications, it can reduce the hazard down to HRC 0.

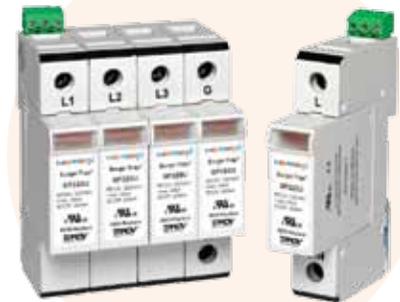
# 2. Surge Protective Device (SPD) Type 4

## PREVIOUS CODE REQUIREMENTS

Article 285 had the transitional phrasing from 2005 to introduce the new term SPD and still use the old term TVSS. UL Standard 1449 Revision 3 was substantially revised so that the name was changed to emphasize the major difference between the safety of a TVSS and an SPD.

The requirements for applying SPD Types 1, 2, and 3 were documented. SPD Type 1 can be used anywhere in the circuit because it is self-protecting within its rating. Type 2 units need upstream protection such as the service entrance. The Type 3 units are to be used more than 30 feet away from the service entrance. The code explained the application for Types 1, 2 and 3 SPDs, but was silent on Type 4.

The prior code did not require SPDs, but through the years the electrical industry determined that they were effective in preventing damage to electronic circuits from voltage spikes and surges. Many SPDs have been voluntarily applied without any code requirements. As electronic equipment becomes more common on all circuits, the potential damage and downtime of critical circuits was becoming apparent.



## 2. Surge Protective Device (SPD) Type 4, *Continued*



### NEW CODE

**285.13 Type 4 and Other Component Type SPDs.** Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

**700.8 Surge Protection.** A listed SPD shall be installed in or on all emergency systems switchboards and panelboards.

### REASONS FOR CHANGES

The term TVSS was edited out of Article 285. The committee decided that there had been sufficient time for the industry to adjust to the SPD term.

Some people were misapplying Type 4 SPDs. Paragraph 285.13 was added to prevent people from applying Type 4 SPDs in the field.

Type 4 SPDs do not have compliance with some of the safety features mandated by Type 1, 2, or 3 SPDs. They are intended to be selected by a panel shop that has the capability of choosing the appropriate characteristics. Type 4 units are often DIN-rail mount and have exposed live terminals. These are suitable for mounting into an enclosure, but not in the open.

New paragraph 700.8 requires surge protection. Article 700 pertains to emergency systems, which are systems legally required to automatically supply power to designated loads upon loss of normal power. This can prevent damage of emergency power controls and damage to critical electronic loads.

### HOW TO COMPLY

Use only Type 1, 2, and 3 SPDs for general field addition. They are designed to safely mitigate harmful surges and voltage spikes. The Type 4 units should be carefully chosen for the application. Sometimes applying them into an enclosure is adequate. Sometimes they have specific upstream protection needs. A qualified person has to analyze the SPD limitations in order to properly apply Type 4 units.

New or modified emergency systems should have SPDs in their switchboards and panelboards. This is the first code requirement for mandatory use of SPDs.

### HELPFUL PRODUCTS

Mersen has a large array of Surge Protective Devices. In addition to the Type 1 and 2 general application products, Mersen has a large variety of Type 4 units.

Mersen Type 4 units are applied to general control panels, PV systems, wind turbines, and power electronics. Type 4 units can be modular or pluggable, AC or DC, and UL or IEC rated.

# 3. Surge Protection Without Overcurrent Protection



## PREVIOUS CODE REQUIREMENTS

Section 240.1 required overcurrent protection to be located at the point where the conductors receive their supply with eight exceptions. This section is commonly called the “Tap Rules.” The prior code did not reference any exceptions for installing Type 1 SPDs that are self protected.

Paragraph 285.23(A)(1) gave permission to wire Type 1 SPDs before or after the service entrance. This paragraph referred to 230.82(4) as giving permission to install these units on the supply side of the service disconnecting means.

## NEW CODE

**240.21(B) Feeder Taps.** Conductors shall be permitted to be tapped, without overcurrent protection at the tap, to a feeder as specified in 240.21(B)(1) through (B)(5). The provisions of 240.4(B) shall not be permitted for tap conductors.

**1. Taps Not over 3m (10 ft) Long.** If the length of the tap conductors does not exceed 3m (10 ft) and the tap conductors comply with all of the following:

(1) The ampacity of the tap conductors is

- a. Not less than the combined calculated loads on the circuits supplied by the tap conductors, and
- b. Not less than the rating of the **equipment containing an overcurrent device(s)** supplied by the tap conductors or not less than the rating of the overcurrent protective device at the termination of the tap conductors.

*Exception to b: Where listed equipment, such as a surge protective device(s) [SPD(s)], is provided with specific instructions on minimum conductor sizing, the ampacity of the tap conductors supplying that equipment shall be permitted to be determined based on the manufacturer's instructions.*

**240.21(C) Transformer Secondary Conductors.** A set of conductors feeding a single load, or each set of conductors feeding separate loads, shall be permitted to be connected to a transformer secondary, without overcurrent protection at the secondary, as specified in 240.21(C)(1) through (C)(6).

*Exception to (C)(2)(1)b: Where listed equipment, such as a surge protective device(s) [SPD(s)], is provided with specific instructions on minimum conductor sizing, the ampacity of the tap conductors supplying that equipment shall be permitted to be determined based on the manufacturer's instructions.*

# 3. Surge Protection Without Overcurrent Protection, *Continued*

## REASONS FOR CHANGES

It was unclear if Type 1 SPDs should have overcurrent protection in their supply side circuit or not. The old code considered the Type 1 units to be self-protected, but was the wire to be considered as protected? If wire was considered protected, how small could it be?

Many SPD manufacturers managed this by recommending additional overcurrent protection sized for the wire supplying the SPD. But if the overcurrent protection was not used, many electrical inspectors would not approve the installation.

## HOW TO COMPLY

The new code has exceptions allowing SPDs and other listed equipment to be installed without additional overcurrent protection. This new exception pertains to feeder taps and transformer secondary taps with distances not exceeding 10 feet.

Select listed SPDs with manufacturer instructions that include minimum wire sizing. This wire sizing and installation have to comply with the other previous requirements for the 10 foot Tap Rule.

## HELPFUL PRODUCTS

Mersen has listed SPDs for most applications. The Mersen models are designed to protect service entrances, panels, and end-use equipment.



# 4. Short Circuit Current Ratings for 1000V



## PREVIOUS CODE REQUIREMENTS

For the first time in the 2005 code, industrial control machinery and panels, air conditioning equipment, refrigeration equipment, meter disconnect switches, and motor controllers had to be marked with their SCCR (Short-Circuit Current Rating).

The 2008 code defined SCCR as, “The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.” Several code sections have specific labeling requirements such as in Section 409 for Industrial Control Panels and Section 670 for Industrial Machinery.

The 2011 code required in 409.22 and also in 670.5 - An industrial panel shall not be installed where the available fault current exceeds its marked short-circuit current rating. This made it a clear code violation to install an industrial control panel rated 600 volts or less with a lower SCCR rating than the available short circuit current.

Also the 2011 code contained a provision in 110.24 requiring field marking of new service entrance equipment with the available short circuit current. That made it easier for electrical inspectors to compare and question the SCCR ratings.

## NEW CODE

### ARTICLE 409: Industrial Control Panels

#### I. General

409.1 Scope. This article covers industrial control panels intended for general use and operating at **1000** volts or less.

## REASONS FOR CHANGES

The National Electrical Code was originally focused on 600 volt equipment. The 2014 code changed the focus to equipment up to 1000 volt equipment. This increases the number of panels required to have SCCR ratings and compliance. For example, a 750 volt solar inverter panel now has to comply.

The code again is emphasizing SCCR labeling and installation requirements. Historically manufacturers began labeling electrical equipment with the SCCR, but many people failed to realize its significance. Some people just assumed it was unimportant labeling. The code mandated the labeling, but the prior codes were unclear how to use this information until 2011.

Some panel buyers only checked for the label, and that the manufacturers provided it. But the equipment could be at dangerously low SCCR levels for the application. The panel users needed more description on how to use the SCCR label information, which was only given in 2011.

# 4. Short Circuit Current Ratings for 1000V, *Continued*

## How to Comply

The new requirement expands the control panels covered by this requirement from 600 volts up to 1000 volts.

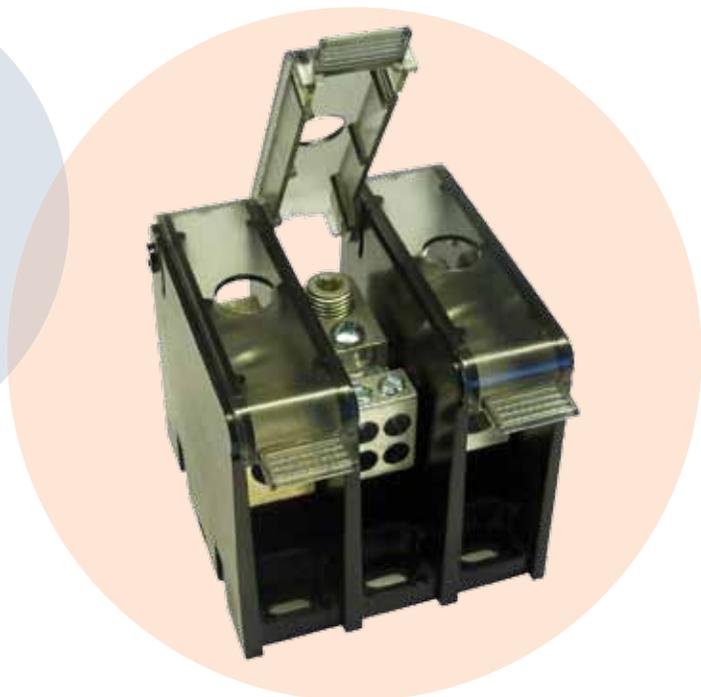
Industrial control and machine panels have to be marked with their SCCR. The manufacturers or designers of the panel must do an analysis as described in UL 508A, even if the panel is not built to the UL 508A Standard specifications.

Then the installer must insure that the panel's SCCR is not less than the available fault at the supply terminals of the panel. Finally the electrical inspector has to verify that the SCCR is on the nameplate and have some evidence that the SCCR is not exceeded.

Compliance can be costly if the person who is responsible for code compliance ignores this code issue until the equipment is installed. Extensive time can be consumed in negotiating who should pay for the problem resolution. The installation fix often requires return of the panel to the manufacturer for upgrading.

## Helpful Products

The Amp-Trap 2000® family delivers current-limiting fuses that can increase the SCCR of industrial control panels. Products such as the UltraSafe™ USFM fuse holder directly replace circuit breakers having the same width as type IEC starters. The Surge-Trap® products protect against voltage spikes and have a built-in rating of up to 200kA SCCR. The finger-safe power distribution blocks can also have a 100kA rating with fuses.



# 5. Solid-State Motor Protection with Fuses

## PREVIOUS CODE REQUIREMENTS

The former 430.52 text used the phrasing “Suitable fuses,” instead of semiconductor fuses. It gave permission to substitute suitable fuses for the requirements of Table 430.52 as long as the equipment was marked to identify suitable replacement fuses.

Section X *Adjustable-Speed Drive Systems* of Article 430 Motors, *Motor Circuits and Controllers* had no information on short circuit and ground fault protective requirements. That meant the non-adjustable speed drive code sections probably applied.

## NEW CODE

### 430.52 Rating or Setting for Individual Motor Circuit.

**(C) (5) Power Electronic Devices.** Semiconductor fuses intended for the protection of electronic devices shall be permitted in lieu of devices listed in Table 430.52 for power electronic devices, associated electromechanical devices (such as bypass contactors and isolation contactors), and conductors in a solid-state motor controller system, provided that the marking for replacement fuses is provided adjacent to the fuses.

### 430.130 Branch-Circuit Short-Circuit and Ground-Fault Protection for Single Motor Circuits Containing Power Conversion Equipment.

**(A) Circuits Containing Power Conversion Equipment.** Circuits containing power conversion equipment shall be protected by a branch-circuit short-circuit and ground-fault protective device in accordance with the following:

(1) The rating and type of protection shall be determined by 430.52(C)(1), (C)(3), (C)(5), or (C)(6), using the full-load current rating of the motor load as determined by 430.6.

(2) Where maximum branch-circuit short-circuit and ground-fault protective ratings are stipulated for specific device types in the manufacturer’s instructions for the power conversion equipment or are otherwise marked on the equipment, they shall not be exceeded even if higher values are permitted by 430.130(A)(1).

(3) A self-protected combination controller shall only be permitted where specifically identified in the manufacturer’s instructions for the power conversion equipment or if otherwise marked on the equipment.

Informational Note: The type of protective device, its rating, and its setting are often marked on or provided with the power conversion equipment.

**(B) Bypass Circuit/Device.** Branch-circuit short-circuit and ground-fault protection shall also be provided for a bypass circuit/device(s). Where a single branch-circuit short-circuit and ground-fault protective device is provided for circuits containing both power conversion equipment and a bypass circuit, the branch-circuit protective device type and its rating or setting shall be in accordance with those determined for the power conversion equipment and for the bypass circuit/device(s) equipment.

**430.131 Several Motors or Loads on One Branch Circuit Including Power Conversion Equipment.** For installations meeting all the requirements of 430.53 that include one or more power converters, the branch-circuit short-circuit and ground-fault protective fuses or inverse time circuit breakers shall be of a type and rating or setting permitted for use with the power conversion equipment using the full-load current rating of the connected motor load in accordance with 430.53. For the purposes of 430.53 and 430.131, power conversion equipment shall be considered to be a motor controller.

# 5. Solid-State Motor Protection with Fuses, *Continued*

## REASONS FOR CHANGES

The prior 430.52 text did not explain what was a suitable fuse. That made the requirement difficult to meet or enforce. Semiconductor fuses are very fast acting current-limiting fuses. The UL Standard 248-13 does not require overload protection in these fuses. Typical branch-circuit rated fuses do contain overload protection. Some fuses are more current-limiting and give better short-circuit and ground-fault protection.

The same selection concerns are present for both power electronic devices and power conversion equipment. Now clearly semiconductor fuses can be used for protection. If they are used, the fuseholder area must be clearly marked which fuse should be used for protecting power conversion equipment.

## HOW TO COMPLY

Power conversion equipment should be coordinated with the manufacturer's instructions. If the manufacturer says fuses, it cannot be protected by circuit breakers. For example, if the power conversion equipment manufacturer states a maximum ampere of a UL Class J fuse, that becomes a code requirement.

## HELPFUL PRODUCTS

Mersen is the largest supplier of semiconductor fuses in the world. Semiconductor fuses are produced in a wide variety of shapes, sizes and ratings.



# 6. Ground Fault Protection (GFP) for 1000A Branches



## PREVIOUS CODE REQUIREMENTS

GFP is for the protection of equipment. Sometimes this requirement is confused with GFCI, which is to protect people from shock. GFCIs are looking for milliamps of current. The GFP can be set to ignore ground faults below 1200 amps and can have time-delay of one second for currents of 3,000 amps or above. The details are in section 230.95.

Prior code mandated GFP for some services and feeders. However if a large branch circuit fit the same description, it was not required to have a GFP.

## NEW CODE

**210.13 Ground-Fault Protection of Equipment.** Each branch-circuit disconnect rated 1000 A or more and installed on solidly grounded wye electrical systems of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, shall be provided with ground-fault protection of equipment in accordance with the provisions of 230.95.

Informational Note: For buildings that contain health care occupancies, see the requirements of 517.17.

*Exception No. 1: The provisions of this section shall not apply to a disconnecting means for a continuous industrial process where a non-orderly shutdown will introduce additional or increased hazards.*

*Exception No. 2: The provisions of this section shall not apply if ground-fault protection of equipment is provided on the supply side of the branch circuit and on the load side of any transformer supplying the branch circuit.*

## REASONS FOR CHANGES

The original requirements for GFP in services and feeders were the result of equipment burn-downs. Although branch circuits this large are uncommon, they exist and some burn-downs have occurred. The new requirement is intended to prevent future burn-downs in large branch circuits of grounded 480 volt systems.

## HOW TO COMPLY

Apply GFP to branch circuits of 480 grounded systems when the overcurrent protection is 1000 amps or more.



## HELPFUL PRODUCTS

Mersen A4BQ Amp-Trap 2000 fuses are faster acting than regular Class L fuses. They can give better protection even if a burn-down starts.

# 7. Sizing Transformer Protection

## PREVIOUS CODE REQUIREMENTS

Transformer protection requirements are divided into two tables, one for lower voltages and the other one for higher voltages. The prior code used 600 volts as the threshold between the two tables, 450.3(A) and (B).

These tables use different criteria for maximum overcurrent protection. Table 450.3(A) considers the impedance of the transformer, and 450.3(B) considers full load currents. There were different rules depending upon whether the voltage was over 600 volts or not.



## NEW CODE

**Table 450.3(A)** Maximum Rating or Setting of Overcurrent Protection for Transformers Over 1000 Volts (as a Percentage of Transformer-Rated Current)

**Table 450.3(B)** Maximum Rating or Setting of Overcurrent Protection for Transformers 1000 Volts and Less (as a Percentage of Transformer-Rated Current)

## REASONS FOR CHANGES

The National Electrical Code was changed in its entirety to more generally apply to circuits up to 1,000 volts instead of 600 volts. Many revisions, mostly editorial, were made to the 2014 code. When so many revisions are made at one time, sometimes unintended consequences result.

## HOW TO COMPLY

Use the tables to select the maximum overcurrent protection allowed. Most transformer applications will not change. Any transformer applications over 600 volts but not over 1,000 volts could have different requirements.

Many higher rated voltage transformer fuse selections could be improved. Historically engineers sized the primary fuses to the maximum allowed by code to avoid nuisance openings. In recent years people became more knowledgeable about the dangers of arc flash and the effects of sizing overcurrent protection.

Transformer fuse application less than the maximum size, but still large enough to prevent nuisance opening, can reduce arc flash hazards. Arc flash incident energy is proportional to the duration of the arc flash. A smaller ampere rated fuse will operate faster with the same amount of arc fault current. Even selecting a more inverse, less time-delay fuse, can reduce arc flash energy using the same ampere rating.

## HELPFUL PRODUCTS

Mersen has the widest range of current-limiting medium voltage fuses for transformers that meet the North American ANSI/IEEE standards. The HMM model of medium voltage fuses can reduce incident energy on the secondary side of the transformer by being installed in the primary. Some medium voltage fuses can reduce arc flash incident energy to tolerable levels using existing fusible gear.

# 8. Solar System Shut-Down for First Responders



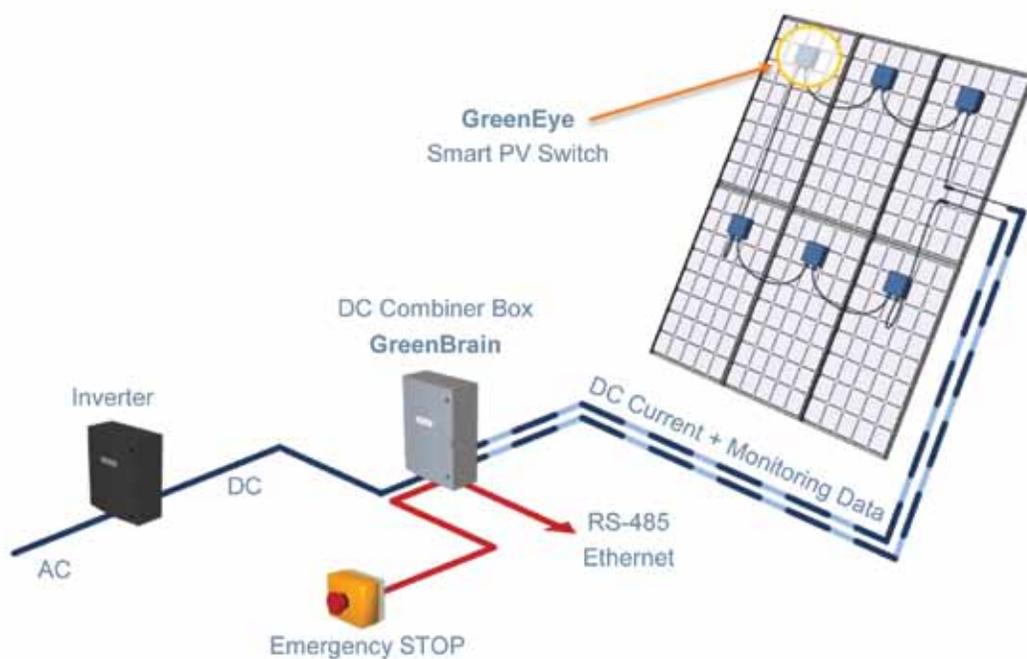
## PREVIOUS CODE REQUIREMENTS

There were no previous requirements for rapid power shutdown on rooftop PV systems. There only were normal shutdown systems incorporating disconnects, inverters, and electronically controlled equipment.

## NEW CODE

**690.12 Rapid Shutdown of PV Systems on Buildings.** PV system circuits installed on or in buildings shall include a rapid shutdown function that controls specific conductors in accordance with 690.12(1) through (5) as follows.

- (1) Requirements for controlled conductors shall apply only to PV system conductors of more than 1.5 m (5 ft) in length inside a building, or more than 3 m (10 ft) from a PV array.
- (2) Controlled conductors shall be limited to not more than 30 volts and 240 volt-amperes within 10 seconds of rapid shutdown initiation.
- (3) Voltage and power shall be measured between any two conductors and between any conductor and ground.
- (4) The rapid shutdown initiation methods shall be labeled in accordance with 690.56(B).
- (5) Equipment that performs the rapid shutdown shall be listed and identified.



# 8. Solar System Shut-Down for First Responders, *Continued*

## REASONS FOR CHANGES

Emergency responders, such as firefighters, are exposed to dangerous voltages from PV systems if they are working on a roof with smoke obstructed view. The normal firefighter procedures of suppression, ventilation, and overhaul entail working on the roof. If the roof has PV systems present, it complicates access and presents dangerous shock hazards.

Europe has extensive experience with their PV systems and has developed some rapid shutdown systems. The new code section was developed after reviewing the related portion of IEC 61730, PV Module Safety Qualification.

## HOW TO COMPLY

Install a rapid shutdown system that will bring the system down to 30 volts or less within 10 seconds of initiation. The code requires that the rapid shutdown system be a listed product. A listed unit meets the key criteria and is already evaluated for easy compliance.

## HELPFUL PRODUCTS

Mersen's PV Safety System has been providing an IEC rapid PV shutdown capability in Europe for some time. Shortly that unit will be modified and UL listed for the Americas.

Mersen has a wide range of other PV products. The traditional products include fuses, fuseblocks, power distribution blocks, disconnect switches, surge protective devices, cooling products, and laminated bus bar solutions.

Recently Mersen introduced a modular PV data collection system. This system collects important data from PV strings, combiner boxes, and other field instruments, and then sends this data over a RS485 communications link.



# 9. Selective Coordination Requirements



## PREVIOUS CODE REQUIREMENTS

The previous code defined selective coordination as, “Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the choice of overcurrent protective devices and their ratings or settings.”

## NEW CODE

**Article 100 Definitions. Coordination (Selective).** Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the **selection and installation** of overcurrent protective devices and their ratings or settings **for the full range of available overcurrents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents.**

**Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts 620.62 Selective Coordination.** Where more than one driving machine disconnecting means is supplied by a single feeder, the overcurrent protective devices in each disconnecting means shall be selectively coordinated with any other supply side overcurrent protective devices.

Selective coordination shall be selected by a licensed professional engineer or other qualified person engaged primarily in the design, installation, or maintenance of electrical systems. The selection shall be documented and made available to those authorized to design, install, inspect, maintain, and operate the system.

**Emergency Systems 700.28 Selective Coordination.** Emergency system(s) overcurrent devices shall be selectively coordinated with all supply-side overcurrent protective devices.

Selective coordination shall be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems. The selection shall be documented and made available to those authorized to design, install, inspect, maintain, and operate the system.

**Legally Required Standby Systems 701.27 Selective Coordination.** Legally required standby system(s) overcurrent devices shall be selectively coordinated with all supply-side overcurrent protective devices.

Selective coordination shall be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems. The selection shall be documented and made available to those authorized to design, install, inspect, maintain, and operate the system.

**708.54 Selective Coordination. Critical operations power system(s) overcurrent devices shall be selectively coordinated with all** supply-side overcurrent protective devices.

Selective coordination shall be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems. The selection shall be documented and made available to those authorized to design, install, inspect, maintain, and operate the system. *Exception: Selective coordination shall not be required between two overcurrent devices located in series if no loads are connected in parallel with the downstream device.*

# 9. Selective Coordination Requirements, *Continued*



## REASONS FOR CHANGES

The code was being interpreted as allowing installations to have limited coordination, instead of fully selective coordination. Many people were unsure if they had selective coordination or not. Even some engineers disagreed what the code requirements were for coordination. Some engineers reasoned that if the system was coordinated on overloads, it was good enough. IEEE Standards have defined selective coordination for many years and the more liberal interpretation of selective coordination was not in compliance.

An example of a non-selectively coordinated system is when a branch circuit is shorted out, causing the feeder and maybe even the main to de-energize. This can happen in a typical building that was not designed with selective coordination as a goal. Then why is it uncommon to see entire buildings lose their power due to a branch overcurrent?

Overcurrents can be broken into two types—overloads and short circuits. Typically an overload is less than 10 times the rated circuit current and the short circuit is over 10 times. Overloads are the most common electrical problem. These common overloads are very easy to selectively coordinate because most fuses and circuit breakers are designed for this performance. As long as the upstream overcurrent device has a higher trip rating, overloads are almost automatically coordinated.

The less common overcurrent is the short circuit. This is when selective coordination can become an engineering task. Unfortunately, short circuits are more likely during a fire or explosion and that is the same time that elevators and emergency electrical systems are most needed. Short circuits have high currents and the overcurrent protective devices respond very rapidly. The rapid response times have to be coordinated so that the smallest portion of the electrical system is taken out of service. If this is accomplished, the system is selectively coordinated.

Electrical inspectors were being asked to rule on the compliance of a system to the selective coordination code requirements. Since even engineers sometimes disagreed, the electrical inspectors were put in a difficult position.

## HOW TO COMPLY

The new code definition is specific that the coordination must be for all types of overcurrents independent of how long the protection devices take to operate. This should resolve the engineers' discussion about the intent of selective coordination.

The code committee found a way to have the electrical inspector enforce without having to be an engineer. The code requires a qualified person, acceptable to the electrical inspector, document the selective coordination status of the installation. The electrical inspector can now just require the documentation.

Selective coordination can be accomplished very easily when originally selecting electrical equipment. However, once the equipment is on the jobsite, sometimes the adjustment ranges of equipment do not permit selective coordination without replacing equipment. The least expensive circuit breaker type, molded case, is problematic for selective coordination.

## HELPFUL PRODUCTS

The easiest way to comply is to use Amp-Trap 2000 fuses. As long as the supply fuses are at least twice the ampere rating of the load fuses, the Amp-Trap 2000 fuses are selectively coordinated. This family of fuses goes up through 6,000 amps.

The Mersen elevator Fusible Shunt Panel assists in easy selective coordination. It uses UL Class J fuses permitting easy coordination between upstream fuses and upstream circuit breakers. The current-limiting fuses cut off the fault current at a low enough level to avoid tripping the upstream breaker in many applications.

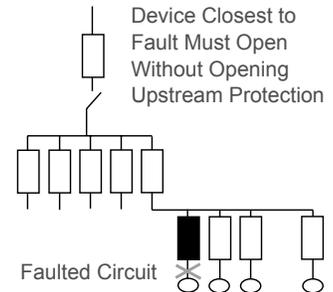
# 10. Selective Coordination Not Required in Hospitals

## PREVIOUS CODE REQUIREMENTS

The 2005 Code selective coordination requirement was expanded to health care facilities, emergency systems and legally required standby systems. The effects of this expansion were well discussed during the 2008 and 2011 code cycles, resulting in some clarification. The code making community reviewed the basics of selective coordination and decided to keep the requirements for selective coordination.

Selective coordination is a description of how an electrical system acts under overcurrents. Most people expect that a single overcurrent in the system would de-energize the local problem and let the rest of the system continue to operate. If the electrical system was not engineered to behave as a selectively coordinated system, a local problem can result in shutting off substantially more of the system than necessary to isolate the problem.

Article 517 used the phrase, “emergency system” in the definition of hospital essential systems. That made hospital essential systems subject to the requirements of Article 700 Emergency Systems. Therefore Article 517 required selective coordination.



## NEW CODE

### Health Care Facilities

**517.2 Definitions. Critical Branch.** A system of feeders and branch circuits supplying power for task illumination, fixed equipment, select receptacles, and select power circuits serving areas and functions related to patient care and that is automatically connected to alternate power sources by one or more transfer switches during interruption of normal power source. [99:3.3.30]

**517.30 Essential Electrical Systems for Hospitals. (G) Coordination. Overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault's duration extends beyond 0.1 second.**

*Exception No. 1: Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary.*

*Exception No. 2: Between overcurrent protective devices of the same size (ampere rating) in series.*

*Informational Note: The terms coordination and coordinated as used in this section do not cover the full range of overcurrent conditions.*

# 10. Selective Coordination Not Required in Hospitals, *Continued*

## REASONS FOR CHANGES

The NFPA organization defines which committee has jurisdiction over occupancies. NFPA assigned the ultimate responsibility for Health Care Facilities electrical systems to the NFPA 99 committee. This Health Care Facilities Code has 15 chapters, one of which is electrical systems.



This multi-discipline committee decided that selective coordination should not be a requirement in hospitals. The NFPA rules dictate that the National Electrical Code cannot contradict NFPA 99. As result the NEC Committee for Health Care Facilities was directed to comply with the deletion of selective coordination requirements.

The NEC committee then complied. They changed the definition of essential electrical systems to delete any reference to emergency systems. That deleted the link to the requirement for selective coordination. Then they added verbatim the coordination requirement from NFPA 99:3.3.30. Finally they added an Informational Note reminding that coordination in this article does not cover the full range of currents.

## HOW TO COMPLY

The NEC requirement is deleted for selective coordination in hospitals. Because the prior code was stricter, there is no new requirement. However, because of potential legal liability of not complying with previous codes, good practice would be to continue the practice of selective coordination with the hospital's approval.

When designing a new electrical system, the sections for selective coordination should be identified first. Although circuit breakers can be selectively coordinated for a given system, the use of the Amp-Trap 2000 family of fuses is more economical.

Within the Amp-Trap 2000 family of fuses a simple 2:1 ratio of the fuse sizes ensures selective coordination. This is due to the current-limiting action of the fuses which are much faster-acting than circuit breakers. The reduction of time and complexity from using circuit breaker systems can reduce the engineering effort to comply with the selective coordination requirements.

If the hospital prefers circuit breakers, fuses can be used only as a transition between sections of the electrical system that are difficult to selectively coordinate.

## HELPFUL PRODUCTS

The selective coordination requirement can be easily met in new systems design using the Amp-Trap 2000 family of fuses. This family enables meeting the requirements even if future electrical system modifications vary the available fault currents.

The Mersen Fused Coordination Panelboard enables selectivity in difficult applications. It consists of circuit breakers and fuses arranged in a panelboard to easily achieve selective coordination.

The Elevator Switch, also called the Fusible Shunt Trip Disconnect, is built for selective coordination of elevator applications. It features a fire safety interface relay with a fire alarm voltage monitoring relay and mechanically interlocked auxiliary contacts. Use of Mersen's Amp-Trap 2000 Class J fuses easily permits selective coordination.



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