What's New in the 2014 NEC®: Arc Energy Reduction

Introduction

Now that the 2014 edition of the National Electrical Code® (NEC®) has been published, let's take a look at what's new in the requirement for arc energy reduction in Section 240.87.

This section was added to Article 240 in the 2011 edition of the National Electrical Code. It required the use of Zone Selective Interlocking (ZSI), differential relaying, energy-reducing maintenance switching or an approved equivalent means where a circuit breaker without an instantaneous trip function is used. This section has changed significantly in the 2014 edition. This Electrical Shortz publication will outline those changes. (Note: quotations from the NEC are shown in italics.) The full text of the section is shown at the end of this document.

What's in a Name?

In the 2011 edition of the NEC, arc energy reduction was required whenever a circuit breaker did not have an instantaneous trip function (see 0100DB1019 “New 2011 NEC Requirement Regarding Non-Instantaneous Trip Circuit Breakers” Electrical Shortz).

In the 2014 edition of the NEC, arc energy reduction is required 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. One may recognize this wording as it is similar to that used in Section 230.95 to define when ground-fault protection of equipment is required. This means that even though an electronic trip circuit breaker with a 1200 A sensor has its current rating switch set to, for example, 0.75 (900 A), it will still require an arc energy reduction means.

If the overcurrent device in the circuit breaker meets this criterion, then documentation and a method to reduce the clearing time must be provided.

Methods to Reduce Clearing Time

Five clearing time reduction means are listed.

1. Zone selective interlocking

Zone selective interlocking preserves the desired coordination between main, tie and feeder protective devices and allows fast tripping for faults within the protected zone (the conductors between the interlocked devices). This is accomplished via wired connections between circuit breaker electronic trip units, ground fault relays or protective relays. If a feeder device detects an overcurrent condition it sends a restraining signal to the upstream device(s). The upstream device(s) then follows its normal time-current characteristics and serves as a backup. However, if the upstream device detects an overcurrent condition above its short time (or ground fault) pickup setting, but the downstream device(s) do not (e.g. due to a main bus fault), then the main circuit breaker will not
receive a restraint signal and it will trip with no intentional time delay. In this way, ZSI offers the “best of both worlds” – fast clearing of fault currents without sacrificing coordination. Furthermore, ZSI is available on both low- and medium-voltage equipment, and can be applied for both phase faults and ground fault protection.

(2) Differential relaying

Differential relaying protection is another option to reduce arc energy. The concept of this protection method is that current flowing into protected zone must equal the current flowing out of the zone. If these two currents are not equal, a fault must exist within the zone, causing the relay to operate. Differential relaying uses current transformers located on the line and load sides of the protected equipment, a fast acting relay and a shunt trip on a circuit breaker or switch. Differential relays are very sensitive to faults inside their zone of protection but are immune to load inrushes or pass-through faults.

Differential relaying protection is often applied at medium voltage and is less common at low voltage due to the increased space requirements for relay class current transformers, differential protective relays and additional wiring complexity. The costs associated for low voltage differential relaying protection are also substantial when compared to the cost of the base equipment.

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

An energy-reducing maintenance switch allows a worker to set a circuit breaker electronic trip unit or protective relay to operate faster should an arc fault occur while the worker is working within the protected zone. After completing the task the worker would then set the maintenance switch back to its normal setting. What the maintenance switch does is to temporarily reduce the pickup and/or time delay settings. In some cases it may even enable an instantaneous trip function. To be effective, the “maintenance mode” settings must result in a faster tripping time based on the actual prospective fault current levels at the location being protected.

(4) Energy-reducing active arc flash mitigation system

An energy-reducing active arc flash mitigation system can reduce the arcing duration by causing the upstream circuit breaker to open more rapidly, or by creating a low impedance current path. The former approach may utilize relays which sense light, current and/or other parameters. Various means to accomplish the latter are available, the most common of which is typically referred to as a “crow bar” switch. The closing of this switch, located within a controlled compartment, will cause the arc fault current to transfer to a new current path while the upstream circuit breaker clears the fault. The system works without compromising existing selective coordination in the electrical distribution system.

(5) An approved equivalent means

Since ZSI, differential relaying and energy-reducing maintenance switches all cause a circuit breaker or switch to open instantaneously should an arc flash occur; it seems obvious that the instantaneous trip function on a circuit breaker should be considered an approved equivalent means. An instantaneous trip function, whether it is field adjustable or a nonadjustable override type, can reduce the arc energy if its pickup point is set below the prospective arc fault current.
Recommendations

This relatively new section in the NEC is well intended, but it is too easy to meet the letter of the requirement without meeting the spirit of the requirement, namely an improvement in worker safety, or even an actual reduction or arc energy. In order to achieve enhanced safety, keep the following in mind:

1. Conduct an arc flash study.
   An arc flash study, involving the determination of the level of the prospective arcing fault current, needs to be performed (see IEEE 1584).

2. Effectively use energy-reducing maintenance switching and instantaneous tripping.
   Make sure that the trip level of any of these means is below the prospective arcing fault current level. Conduct a coordination study to ensure that unwanted tripping will not occur due to high inrush currents that may occur when large motors are started and transformers are energized.

3. Be aware of the protected zone.
   Each of the energy reduction means listed in 240.87 effectively establishes a protected zone; however, the work to be done may not be in the protected zone or may expose the worker to energized conductors outside the protected zone, such as the line side terminals on a main circuit breaker.

4. Arc flash labeling.
   Implementing an energy reduction means listed in 240.87 will not necessarily result in a reduction in the incident energy or Personal Protective Equipment (PPE) category that must be listed on the arc flash label on the equipment per NFPA 70E. In determining the proper labeling of equipment all potential energized conductor exposures must be considered, not just those within the protected zone.

5. Safety by design.
   Consider safety by design techniques such as compartmentalization, protective barriers, insulated bus, remote mounting of main disconnects, etc.

Full Text of 240.87

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.

For More Information

NFPA 70 National Electrical Code 2014 Edition
NFPA 70E, Standard for Electrical Safety in the Workplace®
IEEE 1584, IEEE Guide for Performing Arc Flash Hazard Calculations
0100DB1019, New 2011 NEC Requirement Regarding Non-Instantaneous Trip Circuit Breakers
3000DB0810, Square D Preferred Methods for Arc-Flash Incident Energy Reduction
AT327, Arc Flash Mitigation, white paper by Antony Parsons, Ph.D., P.E., Schneider Electric Engineering Services

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