White Paper **WP005002EN**

Effective December 2017
Supersedes Month XXXX

Changes in NEC 2017 240.87 Code Requirement relative to residential and light commercial metering

Introduction

During the 2011 cycle of the National Electrical Code (NEC®), a new requirement was introduced pertaining to circuit breakers 1200 amp and above, which was meant to also capture those breakers in a 900A frame that could adjust to 1200A, with non-instantaneous trip. This requirement, under the new section 240.87, was introduced with the intent to reduce the opening times of circuit breakers contained in large equipment where high arcflash levels are often present. Initially, this section of the code included three methods of reducing the available arcing current:

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

In 2014, the NEC was revised and section 240.87 was changed to apply to all circuit breakers that are rated or could be adjusted to 1200A and above. The list of allowable means was expanded from three to five methods to also include the following:

1. Zone-selective interlocking
2. Differential relaying
3. Energy-reducing maintenance switching with local status indicator
4. Energy-reducing active arcflash mitigation system
5. An approved equivalent means

The new allowance for "an approved equivalent means" has been pushed in the market by some manufacturers who lack a suitable solution as allowed in 240.87 (1)-(4). It is important to note this solution was subject to approval by the Authority Having Jurisdiction (AHJ) and consequently put more responsibility, diligence and effort on the inspection community. With the publication of the 2017 NEC, two more acceptable means have now been defined to allow for the use of the instantaneous trip setting or override as long as there is an accompanying analysis to ensure arcing current is higher than the instantaneous trip setting of the circuit breaker.

The new list of allowable means in the 2017 NEC is as follows:

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 that is less than the available arcing current
6. An instantaneous override that is less than the available arcing current
7. An approved equivalent means

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It is not sufficient to use only an instantaneous trip or an instantaneous override and assume compliance with 240.87. An additional step is required to determine the arcing current and trip curves for the device. This added step is required because the available current could be low enough that it takes the overcurrent device as many as a few cycles to as long as a few seconds to open, thus avoiding the intent of 240.87. Please note it is important to ensure that the maximum tolerance for the opening time should be used to evaluate compliance with 240.87 (Figure 1). In order to comply with this section, the instantaneous is often set at its minimum setting. This can lead to nuisance tripping, due to the starting current from large motors such as those within HVAC systems, exhaust fans, or elevators. In most cases, manufacturers ship their circuit breakers set at the minimum setting, which can be subject to nuisance tripping issues. In this case the instantaneous settings will need to be increased and could result in an instantaneous trip setting that is higher than the threshold for arcing current. This also creates a situation that encourages adjusting the "as designed" field setting down to the minimum level allowed by the breaker could occur. This practice is not recommended for the following reasons:

- Often times the settings are not returned to their original "as designed" levels if the personnel working on the system did not know or record the settings prior to turning the settings down for maintenance
- Other trades, such as utilities, interfacing with metering mains may not know that they need to turn down the settings to get below the arcing current level or what settings they need to return to following adjustment
- Not all circuit breaker settings are the same and it is often difficult to understand the proper method to adjust these individual settings. In some cases, multiple dials need to be adjusted to achieve the desired setting (Figure 2). This can create further confusion when trying to return them to their "as designed" levels

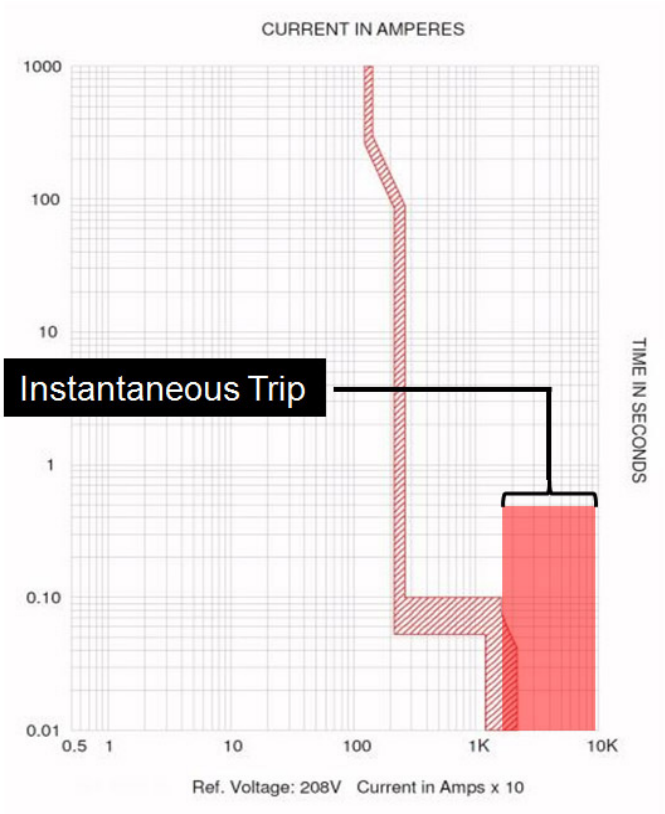
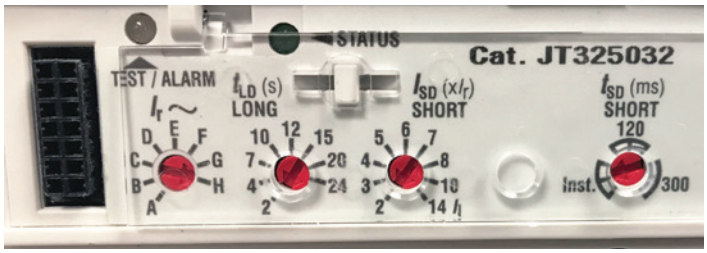
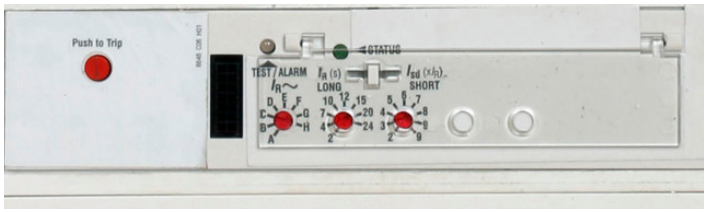


Figure 1 – Arcing current must be above maximum tolerance of trip curve

One of the easiest solutions available to comply with NEC 240.87 is Eaton's Arcflash Reduction Maintenance Switch™. Eaton's Arcflash Reduction Maintenance Switch (ARMS) is a feature available in trip units on Eaton circuit breakers able to be set at 1200A or higher. The Arcflash Reduction Maintenance Switch provides a method to temporarily adjust the circuit breaker to its fastest possible setting while allowing the "as designed" setting to remain the same. This will allow qualified personnel the ability to bypass settings built into the overcurrent device that delay the opening time of the circuit breaker, which is often necessary in installations that require selective coordination or where large inrushes exist due to inductive loads.

Figure 2 – Adjusting instantaneous settings comes in many different styles





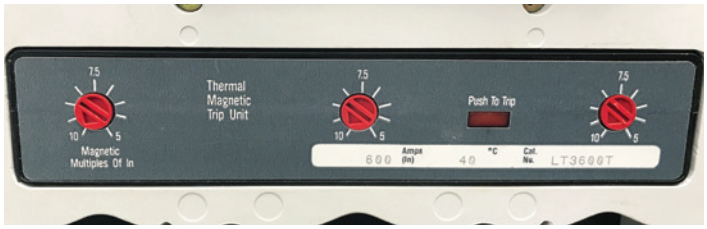


Table 1. Current list of allowable means in section 240.87 of the 2017 NEC and considerations for their use

Method	Change from 2014 NEC	Eaton available solution	Considerations
Zone-selective interlocking	No change	Yes- 310+ Electronic trip units	Slower response time compared to other technologies. Traditionally more expensive option compared to other solutions.
Differential relaying	No change	Yes – E-Series relays	Slower response time compared to other technologies. Considered more relevant for medium voltage applications.
Energy-reducing maintenance switching with local status indicator	No change	Yes – Arcflash Reduction Maintenance Switch	Fastest response time of all the options. Only option that allows the breaker to work "as fast as it can" during maintenance yet maintaining "as designed" setting for normal use. Best option for safety and code compliance.
Energy-reducing active arc flash mitigation system	No change	Yes – Eaton Arcflash Relay	Traditionally more expensive option compared to other solutions.
Instantaneous trip setting that is less than the available arcing current	New requirement	Yes – 310+ Electronic trip units	Acceptable only if arcing current is determined and is higher than the instantaneous setting. Care should be taken not to cause nuisance tripping if set too low and not to create an invitation to adjust the "as designed" settings if they are too high. Extra time, effort, and costs incurred to verify reliability of measurements.
Instantaneous override that is less than the available arcing current	New requirement	Yes – All molded case circuit breaker frames	Acceptable only if arcing current is determined and is higher than the instantaneous setting. Extra time, effort, and costs incurred to verify reliability of measurements.
An approved equivalent means.	No change	Information not available	Up for interpretation by local AHJ.

How does 240.87 affect group metering?

Eaton's industry leading solution for increased safety during maintenance operation employs the 310+ ALSI trip unit. We have added the ALSI trip unit to group metering main circuit breakers from 900-2000A. The ALSI trip units employs the Arcflash Reduction Maintenance System ™, which can improve safety by providing a simple and reliable method to reduce fault clearing times.

What applications require special attention to NEC 240.87?

- Group metering jobs with main service enclosures with circuit breakers 900-2000A

What are the advantages of this trip unit relative to NEC 240.87 2017 requirements?

- Patented peak-sensing measurement is the fastest interrupting breaker in the industry
- No inherent or software delay
- Visual indication of being in maintenance mode
- Simple way to manage temporary settings for service personnel
- Meets requirements of 240.87 (method three) energy reducing maintenance switch with local status indicator

What are the implications of using a standard LSI trip unit?

- NEC 240.87 requires and analysis to be performed to determine the arcing current and assurance that instantaneous trip setting (at maximum tolerance) is set lower than the arcing current
- Not all breakers are the same. Some require multiple dials to be adjusted to lower settings
- There is no control over electrical maintenance skill level. Adjustment of a trip unit is not fool proof and can potentially lead to rendering systems employing selective coordination unreliable once reset
- In some applications, the instantaneous settings will not be lower than available arcing current
- Higher levels of incident energy than what is allowed may occur in arcflash reduction mode because the trip unit is performing RMS calculations of current level
- Setting the instantaneous to low can lead to nuisance tripping due to motor inrush currents on certain loads, such as HVAC and elevators

What do AHJ's and utilities need to know?

- Increased worker safety—when enabled, the Arcflash Reduction Maintenance Switch provides an accelerated instantaneous trip to reduce arcing energies
- The Arcflash Reduction Maintenance Switch is not armed continuously, but designed to be used only during the time that a worker is exposed to the flash hazard. This feature improves overcurrent coordination when compared to a permanently installed instantaneous trip element on the same circuit breaker

Table 2. Incident energy varies with fault duration times where the bolted fault level is 40 kA

Bolted fault (kA)	Arcing fault (kA)	Fault duration (seconds)	Incident energy (cal/cm³)	Hazard risk category
40	20	2	89	> 4
40	20	0.5	22	3
40	20	0.3	13	3
40	20	0.1	4.4	2
40	20	0.05	2.2	1
40	20	0.04	1.8	1
Eaton arcflash reduction mode				

Note: Incident energy values shown in this table were calculating the IEEE STD 158TM-2002 method for a 480 Vac system with a working distance of 24 inches.
Other parameters:

- Grounding type = solid grounded
- Equipment type = switchgear

Sources

- National Electrical Code (NEC) Handbook, 2011 Edition
- National Electrical Code (NEC) Handbook, 2014 Edition
- National Electrical Code (NEC) Handbook, 2017 Edition

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Printed in USA
Publication No. WP005002EN
November 2017

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