NEC 240.67 ARC ENERGY REDUCTION

TECHNICAL PAPER

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ARC ENERGY REDUCTION

The NFPA 70 National Electric Code (NEC) has been updated for 2020. The NEC update adds a new requirement for Arc Energy Reduction regarding the use of fuses. The new requirement is effective January 1, 2020.

Previous Requirement

There were no previous requirements for fuses regarding Arc Energy Reduction. The requirements for Arc Energy Reduction were previously only applicable to circuit breakers rated 1200 A or higher (NEC 240.87).

New Requirement

240.67 Arc Energy Reduction

Where fuses rated 1200 A or higher are installed, 240.67(A), (B), and (C) 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.

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.

(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

(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.

Purpose

Arc energy reduction is critical for electrical safety in the workplace. NEC 2011 introduced an Arc Energy Reduction requirement for circuit breakers (NEC 240.87) rated 1200 A and higher. The added circuit breaker requirement has reduced arc-flash injuries since being introduced by lowering fault clearing times. The value of 0.07 s for the new fuse clearing time requirement was chosen to align with circuit breakers using zone selective interlocking.

However, it should be reinforced that additional arc energy reduction methods ONLY need to be implemented if the specified fuse is greater than 1200 A AND cannot clear the minimum arcing current in less than 0.07 s.

Effectivity Date

The code change goes into effect on January 1, 2020.

Supporting Information

NEC 240.67 is a requirement that relates to arc-fault currents, which is not explicitly defined in NEC. IEEE 1584-2018 defines arc current as "A fault current flowing through an electrical arc plasma." Due to the added impedance of the electrical arc plasma, the value of an arcing fault current will always be less than the bolted fault potential. Typically, an estimated bolted fault current potential for a given system is known. However, arc currents may not always be provided for the same system. Using the estimated bolted fault potential and other system parameters, a minimum available arcing current can be calculated using equations in IEEE 1584-2018, IEEE Guide for Performing Arc Flash Hazard Calculations. This document replaces IEEE 1584-2002, which is referenced in "Informational Note No. 3" of NEC 240.67. Unfortunately, the upper bound of IEEE 1584-2018 is 106 kA. When an electrical system can deliver more than 106 kA to the fuse installation point, there is not an industry accepted method of calculating arcing currents based on bolted fault currents. Call **1-800-TEC-FUSE** or email **techline@littelfuse.com** for technical support when a system's bolted fault current exceeds 106 kA.

Using the standard parameters shown below, minimum available arcing currents for various bolted fault current levels can be calculated using the IEEE 1584-2018 equations. A gap distance of 25 mm is used in this calculation as it is common for electrical equipment that typically uses low voltage industrial fuses such as fused disconnects, MCCs, and panelboards.

Electrical System:	50–60Hz, 3-phase
Voltage:	208, 480, 600 V ac
Equipment Configuration Class:	VCB
Conductor Gap Distance:	25 mm
Bolted Fault Current Levels:	10–106 kA

Figure 1 shows the relationship between calculated minimum arcing currents and estimated bolted fault currents from 10–106 kA. The figure assumes the parameters above applied at three voltages: 208, 480, and 600 V ac.

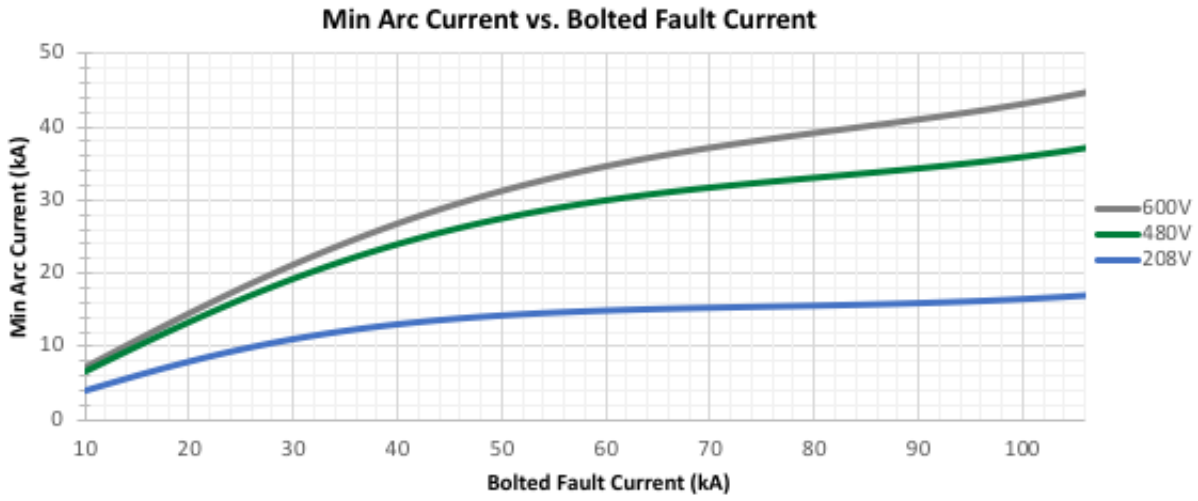

FIGURE 1. Relationship between calculated minimum arcing currents and estimated bolted fault currents.

Compliance

A key point of the NEC 240.67 requirement is that a system shall include a method to reduce arc energy only when the clearing time of the fuse is greater than 0.07 s at the available arcing current. If it can be shown the installed fuse has a clearing time of less than 0.07 s using the fuse's time current curve (TCC), no further consideration is required for compliance.

The following three points can give guidance on being compliant with the NEC 240.67 requirement and general electrical safety.

1. **Not all fuses are created equal**

   1.1. Fuse Current Rating

   Lower fuse ratings will clear a fault faster than higher ratings within the same product series providing arc energy reduction. Some systems may utilize fuses that are oversized for the application. If the specified Class L fuse rating will not clear the arc current in less than 0.07 s, it may be worth recalculating the maximum load current for the system. Noting that Class L fuses can be loaded at 100 % of their rated current, there may be a chance a lower current rating could be utilized leading to compliance. Fortunately, Class L fuses are uniquely designed so that downsizing can occur without equipment changes or adapters.

   1.2. Fuse Series

   Not all Class L fuses series have the same electrical performance. For example, Littelfuse offers three different Class L fuses: KLLU, KLPC, and LDC. Each series offers unique characteristics and fault clearing times. Some series are designed with optimal short circuit and time delay performance (KLPC). Others are designed specifically for exceptional short circuit performance (LDC). The unique designs will therefore lead to varying levels of arcing currents they can clear in less than 0.07 s.

Table 1 shows which Littelfuse Class L series would be a suitable solution and provide compliance with NEC 240.67 by ensuring a fault clearing time of less than .070 s at calculated minimum arcing currents up to 100 kA. Most Class L fuse ratings greater than 1200 A are shown.

2. **Install an Arc-flash Detection System**

   For unique scenarios, a single fuse solution cannot guarantee compliance (see **Table 1**). In these situations, an energy-reducing active arc-flash mitigation system may need to be installed. Littelfuse offers a full line of arc-flash protection relays that meet the requirement in 240.67(B)(3) and 240.87(B)(4) for an energy-reducing active arc-flash mitigation system. These relays use light sensors installed inside the cabinets and switchgear to detect the formation of an arc flash, and provide a high-speed shunt trip (or undervoltage release) signal in less than 5 ms to a circuit breaker or other interrupting device. This high-speed trip signal can significantly reduce the arc energy by ensuring the system is de-energized as quickly as possible. To fit all types of equipment applications, both single-point sensors and innovative fiber-optic light sensors (8 m or 18 m in length) are available. Sensors include active self-check and use copper wiring to connect back to the relay, ensuring installation flexibility and confidence in system operation. Arc-flash relays are available with as few as 2 sensor inputs, and are scalable to any size of system that is needed.

   Table 1 helps identify when an active arc-flash relay should be designed into the system when a fuse alone cannot guarantee full NEC 240.67 compliance.

   See **Littelfuse.com/ArcFlash** or contact **relays@littelfuse.com** for brochures, manuals, and detailed application guides.

3. **Safety First**
   This cannot be stressed enough. Personnel safety should always be a priority, and the best way to ensure this is to always put energized conductors into an electrically safe work condition by putting switches into the OFF position. Authorized personnel should always apply lockout/tagout procedures and approach any conductor as if it were energized. The safest way to work near conductors is when they are de-energized. Even in cases where a maintenance mode is an option, turning the switch OFF provides a safer environment than an activated maintenance mode with the switch ON. When fully de-energizing all conductors is not an option, design features and proper equipment should be implemented to minimize arc-flash energy resulting in maximum personnel safety.

TABLE 1. Littelfuse Arc-Flash Energy Reduction Solutions

FUSE RATING	MINIMUM ARCING CURRENT							
	10 KA	15 KA	20 KA	25 KA	30 KA	35 KA	40 KA	45 KA
1200 A	RELAY	LDC	LDC KLPC	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU
1300 A	RELAY	LDC	LDC	LDC KLPC	LDC KLPC	LDC KLPC	LDC KLPC	LDC KLPC
1350 A	RELAY	RELAY	LDC	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU
1400 A	RELAY	RELAY	LDC	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU
1500 A	RELAY	RELAY	LDC	LDC	LDC KLPC	LDC KLPC	LDC KLPC	LDC KLPC
1600 A	RELAY	RELAY	LDC	LDC	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU
1800 A	RELAY	RELAY	RELAY	LDC	LDC KLLU	LDC KLPC KLLU	LDC KLPC KLLU	LDC KLPC KLLU
1900 A	RELAY	RELAY	RELAY	LDC	LDC	KLPC	LDC KLPC	LDC KLPC
2000 A	RELAY	RELAY	RELAY	RELAY	LDC	LDC KLLU	LDC KLPC KLLU	LDC KLPC KLLU
2100 A	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	KLPC	KLPC
2200 A	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	KLPC	KLPC
2300 A	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	KLPC	KLPC
2400 A	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	KLPC
2500 A	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	KLLU	KLPC KLLU
3000 A	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY	RELAY

Notes

For more information, visit
Littelfuse.com/ArcFlash

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