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EXECUTIVE SUMMARY

Arc Flash Codes & Compliance: What You Need to Know to Deliver Both Protection and Performance

- An arc flash can cause serious injury or death to anyone in its path.
- The National Electrical Code provides installation standards to promote electrical safety and mitigate arc flash risk.
- The right arc flash mitigation solution depends on a business's needs.
- There are six key levels of hazard risk control to consider when evaluating arc flash mitigation solutions.

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Overview

An arc flash event is defined by the National Fire Protection Association (NFPA) as an electrical equipment hazard that is the source of possible injury or damage to health associated with the release of energy caused by an electric arc.

The NFPA's National Electrical Code (NEC), along with NFPA 70E: Standard for Electrical Safety in the Workplace, provides safety standards that can decrease the impact of an arc flash event. Businesses can take advantage of several technologies and product-based solutions to deliver protection while ensuring they meet their organization's performance needs.

Context

Randy Barnett provided an overview of arc flashes and the NEC articles that focus on providing arc flash safety. Tim Ford discussed the hierarchy of hazard control along with key arc flash mitigation solutions businesses can consider to protect their operators.

Key Takeaways

An arc flash can cause serious injury or death to anyone in its path.

Arc flashes can seriously injure—or even kill—workers interacting with live equipment. The rapid release of energy produces extreme temperatures, an ultraviolet light flash and a deafening sound blast causing second-degree burns or worse, blindness, hearing loss, and exposure to shrapnel.

If a person is burned in an arc flash incident, the odds are they're going to be severely burned, if not become a fatality.

Randy Barnett

The severity of an arc flash injury is driven by three key factors that impact the amount of incident energy released:

- **Available fault current** delivered at a particular point in the distribution system.
- **Length of time the arcing current lasts**, which is limited by overcurrent protective devices like circuit breakers and fuses.
- **Distance from the operator to the arc.** Determine the safe distance between the operator and the task plane where an arc may occur to limit the amount of energy exposure. Remote racking devices and chicken switches are two options that add distance between the worker and the equipment. In some situations, the personnel can be moved so they aren't in the path of the arc.

The National Electrical Code provides installation standards to promote electrical safety and mitigate arc flash risk.

Arc flash safety standards first appeared in the 2002 National Electrical Code from the National Fire Protection Association. Updated every three years, the 2017 edition of the NEC includes changes that further protect operators from arc flashes.

- **Article 240.87** address arc energy reduction for circuit breakers where the highest

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continuous current trip setting for which the circuit breaker installed is rated or can be adjusted to 1200 amps (A) or higher. The NEC offers seven ways to comply.

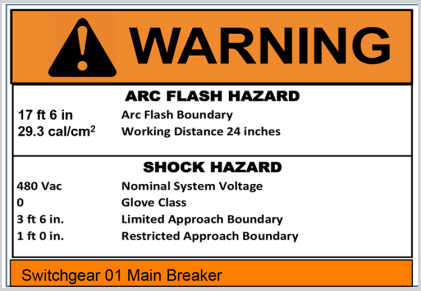
240.87 Technologies for Reducing Arc Energy

- Zone-selective interlocking (ZSI)
- Differential relaying
- Energy-reducing maintenance switch
- Energy-reducing active arc flash mitigation system
- Instantaneous trip setting less than the available arcing current
- Instantaneous override less than the available arcing current
- Approved equivalent means; approved by an authority with jurisdiction

- **Article 240.67** addresses arc energy reduction for fuses rated 1200 A or higher. Effective January 1, 2020, fuses must have a clearing time of 0.07 seconds or less at the available arcing current. Alternately, the circuit may be additionally protected by one of the following: differential relaying, energy-reducing maintenance switching with local status indicator, energy-reducing active arc flash mitigation system, or approved equivalent means.
- **Article 110.16** requires arc flash warning labels for non-residential power distribution and control equipment likely to require maintenance after installation.

  In 2017, 110.16(b) was added to prescribe additional labeling requirements for service entrance equipment. Either of two labels will meet this requirement, both consistent with PPE selection methods described in NFPA 70E. Labels must: 1) include the nominal systems voltage, available fault current at the system, clearing time for the service overcurrent protective device as well as the date of the label. Or 2) be fully compliant with NFPA 70E Arc Flash label requirements described in NFPA 70E 130.5(H).

110.16(b): Arc Flash Hazard Warning Labels (NFPE 70E Compliant)



The right arc flash mitigation solution depends on a business's needs.

A variety of product-based solutions are available for arc flash mitigation. It is important for businesses to have a thorough understanding of their specific situation and know the details of the equipment and system when choosing the optimal solution. A study is often conducted to assess the potential risk and severity of an arc flash incident.

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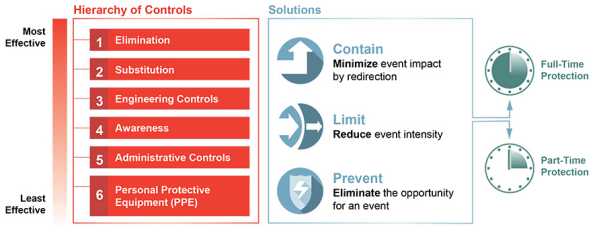
Mitigation requires system knowledge, not necessarily expensive solutions.

Tim Ford

Product-based solutions all fall within the NFPA 70E's six levels of the hierarchy of control, ranging from most effective to least effective:



Products solve the arc flash problem by containing, limiting, or preventing the event, and can provide protection either full-time or part-time.

There are six key levels of hazard risk control to consider when evaluating arc flash mitigation solutions.

Some solutions are listed below with the associated hazard risk control level identified.

1. Arc Resistant Gear

- Hierarchy Level 3: Engineering Control
- Contains by redirecting energy away from the operator through a plenum
- Protection is available only when the equipment doors are closed, which is done manually

Advantages	Disadvantages
– Operator protection as long as the door is closed – Widely available – Visible – Easy to understand	– Isolated but substantial equipment damage – No operator protection if the door is open – High implementation costs – Equipment downtime/ replacement – Rated energy can be exceeded in the incoming compartment

2. Energy-Reducing Maintenance Switch

- Hierarchy Level 5: Administrative Control
- Limits by reducing the event intensity via a circuit breaker tripping response
- Part-time protection; requires manual activation to turn switch on as the default setting is off for optimized uptime and reliability

Advantages	Disadvantages
– Operator protection when on – Widely available simple solution – Minimized nuisance tripping and equipment damage – Cost effective – Visual indication of on/ off state	– Manual operation; requires human intervention to turn on – Higher safety and uptime risk

3. ZSI

- Hierarchy Level 3: Engineering Control
- Arbitrates protection delays in preference of improved (faster) protection without negatively impacting selectivity
- Maintains faster protection even if wiring fails or is cut

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- Simple, commonly available and cost effective to implement

Advantages	Disadvantages
– Uptime and reliability with fast protection and good selective coordination – No human intervention required – Possible to retrofit to existing products – Reduced incident energy, which changes the energy ratings on the label, reducing PPE needs – Threshold-ZSI available in some cases	– Requires coordination study – Requires maintenance

4. Active Arc Flash Mitigation Systems

- Hierarchy Level 3: Engineering Control, or Level 5: Administrative Control, depending on implementation
- Contains by redirecting energy away from the operator to an internal containment zone
- Part-time (administrative control) or full-time (engineering control) protection set via switch

Advantages	Disadvantages
– Operator protection when active, even when the door is open – Minimizes equipment damage – Diagnostics and test capabilities – Reduces incident energy to minimum – Changes the energy ratings on the label when protection is set for full-time, reducing PPE needs	– Expensive add-on – Larger footprint for retrofit and new systems – Not widely offered

5. PtD

- Hierarchy Level 2: Substitution
- Prevents by reducing the opportunity for a bus fault event via non-conductive coating
- Full-time protection; factory-installed non-conductive coating is always on

Advantages	Disadvantages
– Reduces probability of an event – Operator protection across most of the system – Prevents unwanted downtime – Widely available	– Not available system-wide; not all buses can be coated – Cannot retrofit – Expensive – Doesn't satisfy the NEC; code compliance needs to be addressed separately

6. Lock Out/Tag Out

- Hierarchy Level 5: Administrative Control
- Electrically safe condition: personnel do not work on live equipment
- Prevents; nearly removes the possibility of an arc flash occurrence, although some risk remains during the de-energization phase
- Protection requires manual operator intervention to de-energize the equipment

Advantages	Disadvantages
– Best solution, most efficient – No specific equipment is required – Cost-effective	– Requires human intervention, and is therefore subject to human error – Cost prohibitive if using full redundancy to create the electrically safe condition

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Other Important Point

- NFPA 70E is the standard for electrical safety in the workplace. It is not a law, but OSHA can enforce it through the general duty clause. Because it is also an approved consensus standard, it holds up in a court of law.

Biographies

Randy Barnett

NFPA Certified Electrical Professional

Randy Barnett is an NFPA Certified Electrical Safety Compliance Professional with more than 35 years of industrial electrical construction, maintenance and training experience. He is the author of "Commercial and Industrial Wiring" from ATP Publishers, the EC&M Book, "Introduction to Industrial Electrical Maintenance" and numerous articles. Randy conducts electrical code and safety classes worldwide and holds the NCPCCI General Electrical Inspector certificate. He is currently the Electrical Codes and Safety Program Manager for NTT Training.

Tim Ford

Global Product Manager, Molded Case Circuit Breakers, ABB

Tim Ford is the Global Product Manager for Molded Case Circuit Breakers (MCCBs) for ABB's Industrial Solutions business.

He leads product strategy and execution for MCCBs globally. He manages a broad portfolio of circuit breakers products covering all non-residential NEMA/UL and IEC MCCBs including the Spectra and Record Plus branded product and helped develop the industry-first Arc Watch technology based on Instantaneous Zone Selective Interlocking (I-ZSI) to deliver simultaneous safety and reliability.

Tim has more than 20 years' experience in the electrical industry with product development and management roles at both GE and ABB. He holds a Bachelor's of Science Degree in Mechanical Engineering from West Virginia University, and is a licensed Professional Engineer (PE).