

2012 NFPA 70E®

Ten Most Important Changes

John A. DeDad

GE Energy Management
41 Woodford Avenue
Plainville, CT 06062 USA
860-747-7344
John.dedad@ge.com

Abstract —

The 2012 Edition of NFPA 70E®, *Standard for Electrical Safety in the Workplace*, is the ninth edition of this electrical construction industry standard. With over 500 proposals and over 400 public comments received, this edition includes many changes and additions that affect worker safety. The most important of these changes are focused on arc flash and electrical shock hazards and include new tables on selecting proper personal protection equipment (PPE) and clothing, shock protection approach boundaries for DC systems, and maximum three-phase bolted fault currents and circuit breaker clearing times for specific arc ratings of protective clothing and PPE.

Index Terms —

Arc Flash Hazard: A dangerous condition associated with the possible release of energy caused by an electric arc.

Arc Rating: The value, expressed in calories per centimeter squared (cal/cm²), attributed to materials that describes their performance to exposure to an electrical arc discharge.

Boundary, Arc Flash: When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur.

Boundary, Limited Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Boundary, Prohibited Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part.

Boundary, Restricted Approach: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc-over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.

Electrically Safe Work Condition: A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary.

Incident Energy: The amount of energy, expressed in calories per centimeter squared (cal/cm²), impressed on a surface, a certain distance from the source, generated during an electrical arc event.

Introduction —

Prior to the existence of the NFPA 70E® standard, The Occupational Safety and Health Administration (OSHA) was having problems in its attempt to use NFPA 70®, *The National Electrical Code*® (NEC®), as its source of worker electrical safety requirements. OSHA noted that the NEC® was intended for use primarily by those who design, install, and inspect electrical installations, while OSHA's electrical regulations addressed employers and employees in their workplaces. In addition, the technical content and complexity of the NEC® was thought to be extremely difficult for the average employer and employee to understand.

Also, OSHA found that some of the detailed provisions within the NEC® were not directly related to employee safety and, therefore, of little value for its needs.

It also noted that the requirements for electrical safety-related work practices and maintenance of the electrical system, which are considered critical to safety, were not found in the NEC®, which is essentially an electrical installation document.

With these problem areas, it became apparent that there was a true need for a new standard, one tailored to fulfill OSHA's responsibilities while still being fully consistent with the NEC®. This new document would be put together by a competent group that would extract suitable portions from the NEC® as well as from other documents applicable to electrical safety. This would lead to the formulation by NFPA of the Technical Committee on Electrical Safety.

This committee found it feasible to develop a standard for electrical installations that would be compatible with the OSHA requirements for safety for the employee in locations covered by the NEC®. The new standard was visualized as consisting of four major parts: Part I, Installation Safety Requirements; Part II, Safety-Related Work Practices; Part III, Safety-Related Maintenance Requirements; and Part IV, Safety Requirements for Special Equipment. Each part is recognized as being an important aspect of electrical safety in the workplace, but the parts are sufficiently independent of each other to permit their separate publication. [1]

The first edition of NFPA 70E® was published in 1979. Every three years, this committee prepares a new edition that includes additions, revisions, and clarifications derived from proposals and public comments to enhance the effectiveness of this standard.

The 2012 edition of NFPA 70E® marks another waypoint as this standard continues to evolve and meet the electrical safety needs of employers and employees. New research, new technology, and technical input from users of the standard provide the foundation for new and revised requirements that address the electrical hazards encountered by employees in today's workplaces. Revisions that expand or clarify requirements in the 2009 edition, inclusion of new technical material that had not been covered by previous editions of the standard, and removal of requirements that were related to the safe installation of electrical equipment (particularly from Article 320) rather than being safe electrical work practices are some of the major actions undertaken by the Technical Committee on Electrical Safety in the Workplace in this revision cycle. In addition, provisions throughout the standard covering the separate but directly related concepts of hazard identification and risk assessment have been revised to clarify these concepts.[1]

In the opinion of the author, the following ten changes are considered most important.

Change No. 1: Arc-Rated Clothing

A new informational note was added to the definition of the term “arc rated” in Article 100:

Informational Note No. 1: Arc-rated clothing or equipment indicates that it has been tested for exposure to an electric arc. Flame-Resistant (FR) clothing without an arc rating has not been tested for exposure to an electric arc. [1]

This informational note was added to differentiate arc-rated clothing from flame-resistant clothing and to emphasize the fact that arc-rated clothing is flame resistant but flame-resistant clothing may not necessarily be arc rated. The result of this addition is consistency in the selection of protective apparel, as it correlates with the terminology used in applicable ASTM standards. For electrical hazards, arc-rated PPE is necessary because it has been specifically tested for employee protection against the thermal effects of an arc flash. Manufacturers determine the arc rating for protective equipment through their testing. An important part of this required labeling is that all arc-rated clothing is required to include a visibly marked Arc Thermal Performance Exposure Value (ATPV) rating. For example, a complete set of arc-rated protective clothing, in the form of pants, shirt, coveralls and hood, can have an ATPV rating as low as 4 cal/cm² and as high as 40 cal/cm². [2] (See Photo 1.)



Photo 1 (Courtesy of Salisbury by Honeywell)

A hazard/risk category marking alone, such as “HR 3” or “HRC 3,” is not an arc rating and is only appropriate when Table 130.7(C)(15)(a) or (b) in NFPA 70E® is used to select PPE because of the absence of available incident energy information.

Also, beginning with this edition, the term “arc-rated” supplants the previously used term “flame-resistant” throughout the standard.

Change No. 2: Annual Review of Safety-Related Work Practice Compliance

An addition to Sec. 110.2(D) requires that an employer annually determine that its employees are complying with NFPA 70E® requirements:

(f) The employer shall determine, through regular supervision or through inspections conducted on at least an annual basis that each employee is complying with the safety-related work practices required by this standard. [1]

Prior to this edition, there was no specified frequency as to the verification of employee compliance and the employer was left to create its own verification schedule.

Change No. 3: Electrical Safety Program

New additions in Sec. 110.3 (formerly Sec. 110.7) highlight details of the Electrical Safety Program and its required auditing:

(1) Electrical Safety Program. The electrical safety program shall be audited to verify the principles and procedures of the electrical safety program are in compliance with this standard. The frequency of the audit shall not exceed 3 years. [1]

In the prior edition, the frequency of the audit was left up to the employer. This edition clearly establishes a required frequency of this audit, which is every three years maximum.

Still another addition in Sec. 110.3 focuses on Field Work:

(2) Field Work. Field work shall be audited to verify the requirements contained in the procedures of the electrical safety program are being followed. When the auditing determines that the principles and procedures of the electrical safety program are not being followed, the appropriate revisions to the training program or revisions to the procedures shall be made. [1]

The prior edition simply stated that “appropriate revisions shall be made.” This edition further clarifies that the changes must be made to the training program and procedures that the employer has in place. For an employer to verify that its employees are following its electrical safety program in their day-to-day activities, the employer must audit all field work. By doing so, the employer will get a thorough assessment of the overall effectiveness of the employees’ implementation of its electrical safety plan. If the field work audit yields results indicating that employees are not adhering to the electrical safety program, the employer is required by NFPA 70E® to consider revisions to the training provided to its employees and/or changes to one or more procedures contained within the overall electrical safety program. [2]

Finally, a third addition in Sec. 110.3 details the auditing requirement:

“(3) Documentation. The audit shall be documented.” [1]

This is a new requirement as the previous edition made no mention of documentation.

Change No. 4: Underground Electrical Lines and Equipment

A new section regarding excavating near existing underground conductors is added to Article 110:

110.5 Underground Electrical Lines and Equipment.

Before excavation starts, and where there exists a reasonable possibility of contacting electrical lines or equipment, the employer shall take the necessary steps to contact the appropriate owners or authorities to identify and mark the location of the electrical lines or equipment. When it has been determined that a reasonable possibility for contacting electrical lines or equipment exists, a hazard analysis shall be performed to identify the appropriate safe work practices that shall be used during the excavation. [1]

Excavating near underground electrical lines and working in a trench in close proximity to underground electrical lines can expose employees to shock or arc flash hazards. To minimize the possibility of accidental contact with these conductors and equipment, this edition of NFPA 70E® requires the marking of their location prior to beginning any excavation. Depending on the location of the buried conductors and equipment, this may also be required by local “call-before-digging” programs. [2]

This edition of the standard also requires the use of safe work practices relative to the hazard during the excavation if contacting underground lines is possibly unavoidable.

Change No. 5: Electrically Safe Working Conditions

New wording added to Sec. 130.2 details when energized conductors must be put into electrically safe working conditions:

130.2 Electrically Safe Working Conditions. Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work if either of the following conditions exists:

(1) The employee is within the limited approach boundary.

(2) The employee interacts with equipment where conductors or circuit parts are not exposed, but an increased risk of injury from an exposure to an arc flash hazard exists. [1]

Basically, this addition is saying that any work performed within the limited approach boundary and/or within the arc flash boundary must be justified if the risk of injury to the employee is elevated because the work has to be performed while energized. Also, enclosed energized equipment must be placed in an electrically safe work condition if any work involving interaction with this equipment results in an increased risk of injury from an arc flash incident.

The extent of this elevated risk of injury can be determined by using a hazard identification and risk assessment procedure noted in Sec. 110.3(F). This same procedure can also be used to validate the application of the exception to this section, which permits operation of energized equipment where the risk of an arc flash injury to an employee is acceptably low. [2]

Change No. 6: Energized Electrical Work Permit

Newly added wording in Sec. 130.2(B) [formerly Sec. 130.1(B)] noted in bold below, clarifies the working areas where an Energized Electrical Work Permit is required:

(1) When Required. When working within the limited approach boundary or the arc flash boundary of exposed energized electrical conductors or circuit parts that are not placed in an electrically safe work condition..., work to be performed shall be considered energized electrical work and shall be performed by written permit only. [1]

This added wording details and somewhat quantifies the areas where an energized electrical work permit is required, specifically within the limited approach boundary or arc flash boundary. The previous edition simply said that this permit was required “when working on energized electrical conductors or circuit parts.”

The energized electrical work permit ensures that the increased risk, along with increased possibility of injuries, gets the consideration it certainly deserves. Many times, owners and plant/facility managers do not always understand the hazards associated with working within the limited approach and/or arc flash boundary because they are unwilling to slow or stop production. Also, employees may feel the need to accept this exposure as part of their concern to retain a good client.

The energized electrical work permit correlates with OSHA's requirement to de-energize the equipment or circuit except under specific conditions and ensures that all affected personnel understand that exposure to an electrical hazard is increased when the equipment must remain energized while the work task is performed.

By signing the permit, the person authorizing the work is accepting responsibility for the exposure. The seriousness of this responsibility could possibly lead to an alternative way to complete the required work without exposing workers to electrical hazards. [2]

Change No. 7: Elements of Work Permit

New information added in Sec. 130.2(B)(2) details the required elements of the Energized Electrical Work Permit relative to the shock hazard analysis:

- a. Limited approach boundary [see 130.4(B) and Table 130.4(C)(a) and Table 130.4(C)(b)]*
- b. Restricted approach boundary [see 130.4(B) and Table 130.4(C)(a) and Table 130.4(C)(b)]*
- c. Prohibited approach boundary [see 130.4(B) and Table 130.4(C)(a) and Table 130.4(C)(b)]*
- d. Necessary shock personal and other protective equipment to safely perform the assigned task [see 130.4(C), 130.7(C)(1) through (C)(16), Table 130.7(C)(15)(a), Table 130.7(C)(15)(b), and Table 130.7(C)(16), and 130.7(D)] [1]*

This added wording clearly lists the items required to be included in any shock hazard analysis and includes references to pertinent NFPA 70E® tables. The previous edition simply stated that this analysis "shall determine the voltage to which personnel will be exposed, boundary requirements, and personal protective equipment necessary to minimize the possibility of electrical shock to personnel."

Also, new information added in Sec. 130.2(B)(5) details the required elements of the Energized Electrical Work Permit relative to the arc flash hazard analysis:

- a. Available incident energy or hazard/risk category [see 130.5]*
- b. Necessary personal protective equipment to safely perform the assigned task [see 130.5(B), 130.7(C)(1) through (C)(16), Table 130.7(C)(15)(a), Table 130.7(C)(15)(b), and Table 130.7(C)(16), and 130.7(D)]*
- c. Arc flash boundary [see 130.5(A)] [1]*

This added wording clearly lists the items required to be included in any arc flash hazard analysis and includes references to pertinent NFPA 70E® tables. The previous edition simply stated that this analysis "shall determine the Arc Flash Protection Boundary and the personnel protective equipment that people within the Arc Flash Boundary shall use."

When an energized work permit is created, it is important that the items listed in 130.2(B)(2) be considered for shock and arc flash hazard and that supporting evidence of valid concern is provided. [2]

Change No. 8: Approach Boundaries for Shock Protection, DC Voltage Systems

A new Table 130.4(C)(b) added to Article 130 lists shock protection approach boundaries to energized electrical conductors or circuit parts in DC voltage systems. These approach boundaries represent distances from any exposed energized electrical conductors or circuit parts to a qualified worker. If the qualified person must approach an exposed energized electrical conductor closer than the restricted approach boundary, insulating materials with a defined voltage rating must be placed between the person and the conductor. This insulating material can take several forms. For example, it can be installed so that the conductor is insulated from possible contact, or the worker can be insulated by wearing appropriately rated personal protective equipment. Also, the worker can be insulated from ground, as in live-line bare-hand work. In some cases, more than one protective scheme can be used, such as installing rated rubber blankets to cover one or more conductors and wearing appropriate voltage-rated personal protective equipment. [2]

Approach Boundaries^a for Shock Protection – DC Voltage Systems

Nominal DC Potential Difference	Limited Approach Boundary	Limited Approach Boundary	Restricted Approach Boundary	Prohibited Approach Boundary
	Exposed Movable Conductor ^b	Exposed Fixed Circuit Part		
< 100V	Not specified	Not specified	Not specified	Not specified
100V – 300V	3.0 m (10 ft., 0 in.)	1.0 m (3 ft., 6 in.)	Avoid contact	Avoid contact
301V – 1kV	3.0 m (10 ft., 0 in.)	1.0 m (3 ft., 6 in.)	0.3 m (1 ft., 0 in.)	25mm (0 ft., 1 in.)
1.1kV – 5kV	3.0 m (10 ft., 0 in.)	1.5 m (5 ft., 0 in.)	0.5 m (1 ft., 5 in.)	0.1 m (0 ft., 4 in.)
5.1kV – 15kV	3.0 m (10 ft., 0 in.)	1.5 m (5 ft., 0 in.)	0.7 m (2 ft., 2 in.)	0.2 m (0 ft., 7 in.)
15.1kV – 45kV	3.0 m (10 ft., 0 in.)	2.5 m (8 ft., 0 in.)	0.8 m (2 ft., 9 in.)	0.4 m (1 ft., 5 in.)
45.1kV – 75kV	3.0 m (10 ft., 0 in.)	2.5 m (8 ft., 0 in.)	1.0 m (3 ft., 2 in.)	0.7 m (2 ft., 1 in.)
75.1kV – 150kV	3.3 m (10 ft., 8 in.)	3.0 m (10 ft., 0 in.)	1.2 m (4 ft., 0 in.)	1.0 m (3 ft., 2 in.)
150.1kV – 250kV	3.6 m (11 ft., 8 in.)	3.6 m (11 ft., 8 in.)	1.6 m (5 ft., 3 in.)	1.5 m (5 ft., 0 in.)
250.1kV – 500kV	6.0 m (20 ft., 0 in.)	6.0 m (20 ft., 0 in.)	3.5 m (11 ft., 6 in.)	3.3 m (10ft,10in.)
500.1kV – 800kV	8.0 m (26 ft., 0 in.)	8.0 m (26 ft., 0 in.)	5.0 m (16 ft., 5 in.)	5.0 m (16 ft., 5 in.)

a All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.

b Describes condition in which distance between conductor and person is not under control of person and usually applies to overhead line conductors supported by poles.

Table 130.4(C)(b) [1]

Change No. 9: Arc Flash Labeling

New wording in Sec. 130.5(C) Equipment Labeling [formerly Sec 130.3(C)] lists required information to be included on an arc flash label:

(C) Equipment Labeling. Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling units, and are likely to require examination, adjustment, servicing, or maintenance while energized, shall be field marked with a label containing all the following information:

(1) At least one of the following:

- a. Available incident energy and the corresponding working distance*
- b. Minimum arc rating of clothing*
- c. Required level of PPE*
- d. Highest Hazard/Risk Category (HRC) for the equipment*

(2) Nominal system voltage

(3) Arc flash boundary

Exception: Labels applied prior to September 30, 2011, are acceptable if they contain the available incident energy or required level of PPE.

The method of calculating and data to support the information for the label shall be documented. [1]

This new wording clearly expands the amount of information required on an arc flash label. (See Photo 2.) The exception provides some flexibility regarding the use of existing labels, but only if they include information on the available incident energy or required level of personal protective equipment. The previous edition simply stated that “equipment shall be field marked with a label containing the available incident energy or required level of PPE.”

WARNING	
Arc Flash and Shock Hazard Appropriate PPE Required	
1' - 8.7" 27.7 #4	Flash Hazard Boundry cal/cm ² Flash Hazard at 18 Inches PPE Level Cotton Underwear + FR Shirt & Pants + Multi Layer Flash Suit
480V 0' - 8" 0' - 4.5" 0' - 3.6"	Voltage Shock Hazard When Cover Is Removed Limited Approach Restricted Approach Prohibited Approach
Equipment: MDP	

Photo 2 (Courtesy of Dolphins Software)

Change No. 10: Selecting Protective Clothing and Other PPE

A newly added Table H.3(b) in Annex H lists incident energy exposure in cal/cm², as determined by a hazard analysis, and corresponding clothing and personal protective equipment. This table is an excellent quick guide for the selection of clothing and PPE.

New Table H.3(b): Protective Clothing and Other PPE

Incident Energy Exposure	Protective Clothing and PPE
Less than or equal to 1.2 cal/cm²	
Protective clothing, nonmelting (in accordance with ASTM F 1506-08) or untreated natural fiber	Shirt (long sleeve) and pants (long) or overall
Other personal protective equipment	Face shield for projectile protection (AN); safety glasses or safety goggles (SR); hearing protection; heavy-duty leather gloves or rubber insulating gloves with leather protectors (AN)
Greater than 1.2 to 12 cal/cm²	
Arc-rated clothing and equipment with an arc rating equal to or greater than the incident energy determine in a hazard analysis (See Note 3)	Arc-rated long-sleeve shirt and arc-rated pants or arc-rated coveralls or arc flash suit (SR) (See Note 3); arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR) (See Note 1); arc-rated jacket, parka, or rainwear (AN).
Greater than 12 cal/cm²	
Arc-rated clothing and equipment with an arc rating equal to or greater than the incident energy determined in a hazard analysis (See Note 3)	Arc-rated long-sleeve shirt and arc-rated pants or arc-rated coveralls and/or arc flash suit (SR); arc-rated arc flash suit hood; arc-rated gloves; arc-rated jacket, parka, or rainwear (AN).
Other personal protective equipment	Hard hat; arc-rated hard hat liner (AN); safety glasses or safety goggles (SR); hearing protection; arc-rated leather gloves or rubber insulating gloves with leather protectors (SR) (See Note 4); leather work shoes.
<p>AN: As needed [In addition to the protective clothing and PPE required by 130.5(B)(1)]</p> <p>SR: Selection of one in group is required by 130.5(B)(1)</p> <p>Note 1: Face shields with wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.8(C)(10)(c). For full head and neck protection, use a balaclava or an arc flash hood.</p>	<p>Note 2: All items not designated "AN" are required by 130.7(C).</p> <p>Note 3: Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system consisting of a combination of arc-rated shirt and pants, coverall, and arc flash suit.</p> <p>Note 4: Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.</p>

Table H.3(b) [1]

Also newly added in Annex H is Table H.3(a), which provides much needed guidance on applicable NFPA 70E sections relative to shock hazard PPE and arc flash hazard PPE.

Finally, the 2012 edition includes newly added Table H.4(a) and Table H.4(b) in Annex H, which provide maximum three-phase bolted fault current limits at low voltage systems (208V through 690V) and high voltage systems (5kV, 12kV, and 15kV) respectively, along with circuit breaker fault clearing times for the recommended use of 8 cal/cm² and 40 cal/cm² PPE in what is term an “arc-in-a-box” situation. The limitations noted in these tables are based on IEEE 1584 calculation methods. [2]

Conclusion —

Electrical construction work can be very dangerous as almost all members of the electrical construction industry workforce are exposed to electrical energy every day as they perform their duties. NFPA 70E® has educated the industry on the hazards associated with electrical construction work so that electrical employers and their workers have become more knowledgeable in providing and using protection from these hazards. This is the main reason why NFPA 70E® has maintained its importance in our industry.

Acknowledgement —

The author wishes to thank Marcello Valdes, Senior Product Manager, and John McQuilken, Lead Field Engineer, GE Energy Management, for clarifications to the intent of the 2012 edition changes and suggested corrections to the content of this paper.

References —

1. NFPA 70E®, *Standard for Electrical Safety in the Workplace*, 2012 Edition
2. NFPA 70E® *Handbook for Standard for Electrical Safety in the Workplace*, 2012 Edition