

# National Electrical Code (NEC) NFPA 70

## 110.16 Arc-Flash Hazard Warning.

**(A) General.** Electrical equipment, such as switchboards, switchgear, panelboards, industrial control panels, meter socket enclosures, and motor control centers, that is in other than dwelling units, and is likely to require examination, adjustment, servicing, or maintenance while energized, shall be field or factory marked to warn qualified persons of potential electric arc flash hazards. The marking shall meet the requirements in 110.21(B) and shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

**(B) Service Equipment.** In other than dwelling units, in addition to the requirements in (A), a permanent label shall be field or factory applied to service equipment rated 1200 amps or more. The label shall meet the requirements of 110.21(B) and contain the following information:

- (1) Nominal system voltage
- (2) Available fault current at the service overcurrent protective devices
- (3) The clearing time of service overcurrent protective devices based on the available fault current at the service equipment
- (4) The date the label was applied

**Exception:** *Service equipment labeling shall not be required if an arc flash label is applied in accordance with acceptable industry practice.*

**Informational Note No. 1:** *NFPA 70E -2015, Standard for Electrical Safety in the Workplace, provides guidance, such as determining severity of potential exposure, planning safe work practices, arc flash labeling, and selecting personal protective equipment.*

**Informational Note No. 2:** *ANSI Z535.4-2011, Product Safety Signs and Labels, provides guidelines for the design of safety signs and labels for application to products.*

**Informational Note No. 3:** *Acceptable industry practices for equipment labeling are described in NFPA 70E -2015 Standard for Electrical Safety in the Workplace. This standard provides specific criteria for developing arc-flash labels for equipment that provides nominal system voltage, incident energy levels, arc-flash boundaries, minimum required levels of personal protective equipment, and so forth.*

## 110.18 Arcing Parts.

Parts of electrical equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

**Informational Note:** *For hazardous (classified) locations, see Articles 500 through 517. For motors, see 430.14.*

# National Fire Prevention Code (NFPA) 70E

## 110.8 Working on or Near Electrical Conductors or Circuit Parts.

**(A) General.** Safety-related work practices shall be used to safeguard employees from injury while they are working on or near exposed electric conductors or circuit parts that are or can become energized. The specific safety-related work practice shall be consistent with the nature and extent of the associated electric hazards.

(1) Live Parts—Safe Work Condition. Live parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee works on or near them, unless work on energized components can be justified according to 130.1.

(2) Live Parts—Unsafe Work Condition. Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.

(B) Working On or Near Exposed Electrical Conductors or Circuit Parts that Are or Might Become Energized. Prior to working on or near exposed electrical conductors and circuit parts operating at 50 volts or more, lockout/tagout devices shall be applied in accordance with 120.1, 120.2, and 120.3. If, for reasons indicated in 130.1, lockout/tagout devices cannot be applied, 130.2(A) through 130.2(D)(2) shall apply to the work.

(1) Electrical Hazard Analysis. If the live parts operating at 50 volts or more are not placed in an electrically safe work condition, other safety-related work practices shall be used to protect employees who might be exposed to the electrical hazards involved. Such work practices shall protect each employee from arc flash and from contact with live parts operating at 50 volts or more directly with any part of the body or indirectly through some other conductive object. Work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the live parts. Appropriate safety-related work practices shall be determined before any person approaches exposed live parts within the Limited Approach Boundary by using both shock hazard analysis and flash hazard analysis.

(a) Shock Hazard Analysis. A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electrical shock to personnel.

*FPN: See 130.2 for the requirements of conducting a shock hazard analysis.*

(b) Flash Hazard Analysis. A flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection Boundary and the personal protective equipment that people within the Flash Protection Boundary shall use.

*FPN: See 130.3 for the requirements of conducting a flash hazard analysis.*

(2) Energized Electrical Work Permit. If live parts are not placed in an electrically safe work condition (i.e., for the reasons of increased or additional hazards or infeasibility per 130.1), work to be performed shall be considered energized electrical work and shall be performed by written permit only.

*FPN: See 130.1(A) for the requirements of an energized electrical work permit.*

(3) Unqualified Persons. Unqualified persons shall not be permitted to enter spaces that are required under 400.16 to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.

(4) Safety Interlocks. Only qualified persons following the requirements for working inside the Restricted Approach Boundary as covered by 130.2(C) shall be permitted to defeat or bypass an electrical safety interlock over which the person has sole control, and then only temporarily while the qualified person is working on the equipment. The safety interlock system shall be returned to its operable condition when the work is completed.

## **130.2 Approach Boundaries to Live Parts.**

(A) Shock Hazard Analysis. A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electric shock to personnel.

(B) Shock Protection Boundaries. The shock protection boundaries identified as Limited, Restricted, and Prohibited Approach Boundaries are applicable to the situation in which approaching personnel are exposed to live parts. See Table 130.2(C) for the distances associated with various system voltages.

*FPN: In certain instances, the Flash Protection Boundary might be a greater distance from the exposed live parts than the Limited Approach Boundary.*

(C) Approach to Exposed Live Parts Operating at 50 Volts or More. No qualified person shall approach or take any conductive object closer to exposed live parts operating at 50 volts or more than the Restricted Approach Boundary set forth in Table 130.2(C), unless any of the following apply:

(1) The qualified person is insulated or guarded from the live parts operating at 50 volts or more (insulating gloves or insulating gloves and sleeves are considered insulation only with regard to the energized parts upon which work is being performed), and no uninsulated part of the qualified person's body crosses the Prohibited Approach Boundary set forth in Table 130.2(C).

(2) The live part operating at 50 volts or more is insulated from the qualified person and from any other conductive object at a different potential.

(3) The qualified person is insulated from any other conductive object as during live-line bare-hand work.

**Table 130.4(D)(a) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems**

Nominal System Voltage Range Phase to Phase	Limited Approach Boundary (Unqualified workers must not cross)		Restricted Approach (Qualified Person Requires Voltage Rated PPE to Cross)
	Exposed Movable Conductor	Exposed Fixed Circuit Part	
Less than 50 V	Not Specified	Not Specified	Not Specified
50 V – 150 V	10 ft 0 in (3.0 m)	3 ft 6 in (1.0 m)	Avoid Contact
151 V – 750 V	10 ft 0 in (3.0 m)	3 ft 6 in (1.0 m)	1 ft 0 in (0.3 m)
751 V - 15 kV	10 ft 0 in (3.0 m)	5 ft 0 in (1.5 m)	2 ft 2 in (0.7 m)
15 kV - 36 kV	10 ft 0 in (3.0 m)	6 ft 0 in (1.8 m)	2 ft 9 in (0.8 m)
36.1 kV – 46 kV	10 ft 0 in (3.0 m)	8 ft 0 in (2.5 m)	2 ft 9 in (0.8 m)
46.1 kV – 72.5 kV	10 ft 0 in (3.0 m)	8 ft 0 in (2.5 m)	3 ft 6 in (1.0 m)
72.6 kV – 121 kV	10 ft 8 in (3.3 m)	8 ft 0 in (2.5 m)	3 ft 6 in (1.0 m)
138 kV – 145 kV	11 ft 0 in (3.4 m)	10 ft 0 in (3.0 m)	3 ft 10 in (1.2 m)
161 kV – 169 kV	11 ft 8 in (3.6 m)	11 ft 8 in (3.6 m)	4 ft 3 in (1.3 m)
230 kV – 242 kV	13 ft 0 in (4.0 m)	13 ft 0 in (4.0 m)	5 ft 8 in (1.7 m)
345 kV – 362 kV	15 ft 4 in (4.7 m)	15 ft 4 in (4.7 m)	9 ft 2 in (2.8 m)
500 kV – 550 kV	19 ft 0 in (5.8 m)	19 ft 0 in (5.8 m)	11 ft 8 in (3.6 m)
765 kV – 800 kV	23 ft 9 in (7.2 m)	23 ft 9 in (7.2 m)	15 ft 11 in (4.9 m)

**Notes:**

(1) For arc flash boundary, see 130.5(A).

(2) All dimensions are distance from exposed energized electrical conductors or circuit part to employee.

- a. For single-phase systems above 250 volts, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.
- b. See definition in Article 100 and text in 130.4(D)(2) and Informative Annex C for elaboration.

PO Box 1366  
Mansfield, Ohio 44901  
Toll Free 855-887-8463  
Phone 419-522-3030  
Fax 419-522-3033  
Web Site: [www.spgsamerica.com](http://www.spgsamerica.com)  
E-mail [Levi@spgsamerica.com](mailto:Levi@spgsamerica.com)



**Safety Protection  
Grid Solutions**

- c. Exposed movable conductors describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.
- d. This includes circuits where the exposure does not exceed 120 volts nominal.

**Table 130.4(D)(b) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Direct-Current Voltage Systems**

Nominal Potential Difference	Limited Approach Boundary (Unqualified workers must not cross)		Restricted Approach Boundary (Qualified Person Requires Voltage Rated PPE to Cross)
	Exposed Movable Conductor	Exposed Fixed Circuit Part	
Less than 50 V	Not Specified	Not Specified	Not Specified
50 V – 300 V	10 ft 0 in (3 m)	3 ft 6 in (1 m)	Avoid Contact
301 V – 1kV	10 ft 0 in (3 m)	3 ft 6 in (1 m)	1 ft 0 in (0.3 m)
1,1 kV - 5 kV	10 ft 0 in (3 m)	5 ft 0 in (1.5 m)	1 ft 5 in (0.5 m)
5 kV - 15 kV	10 ft 0 in (3 m)	5 ft 0 in (1.5 m)	2 ft 2 in (0.7 m)
15.1 kV – 45 kV	10 ft 0 in (3 m)	8 ft 0 in (2.5 m)	2 ft 9 in (0.8 m)
45.1 kV – 75 kV	10 ft 0 in (3 m)	8 ft 0 in (2.5 m)	3 ft 6 in (1.0 m)
75.1 kV – 150 kV	10 ft 8 in (3.3 m)	10 ft 0 in (3.0 m)	3 ft 10 in (1.2 m)
150.1 kV – 250 kV	11 ft 8 in (3.6 m)	11 ft 8 in (3.6 m)	5 ft 3 in (1.6 m)
250.1 kV – 500 kV	20 ft 0 in (6.0 m)	20 ft 0 in (6.0 m)	11 ft 6 in (3.5 m)
500.1 kV – 800 kV	26 ft 0 in (8 m)	26 ft 0 in (8.0 m)	16 ft 5 in (5.0 m)

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

\*Exposed movable conductor describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

(D) Approach by Unqualified Persons. Unqualified persons shall not be permitted to enter spaces that are required under 400.16(A) to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.

(1) Working At or Close to the Limited Approach Boundary. Where one or more unqualified persons are working at or close to the Limited Approach Boundary, the designated person in charge of the work space where the electrical hazard exists shall cooperate with the designated person in charge of the unqualified person(s) to ensure that all work can be done safely. This shall include advising the unqualified person(s) of the electrical hazard and warning him or her to stay outside of the Limited Approach Boundary.

(2) Entering the Limited Approach Boundary. Where there is a need for an unqualified person(s) to cross the Limited Approach Boundary, a qualified person shall advise him or her of the possible hazards and continuously escort the unqualified person(s) while inside the Limited Approach Boundary. Under no circumstance shall the escorted unqualified person(s) be permitted to cross the Restricted Approach Boundary.

**130.3 Flash Hazard Analysis.**

A flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection Boundary and the personal protective equipment that people within the Flash Protection Boundary shall use.

PO Box 1366  
 Mansfield, Ohio 44901  
 Toll Free 855-887-8463  
 Phone 419-522-3030  
 Fax 419-522-3033  
 Web Site: [www.spgsamerica.com](http://www.spgsamerica.com)  
 E-mail [Levi@spgsamerica.com](mailto:Levi@spgsamerica.com)



(A) Flash Protection Boundary. For systems that are 600 volts or less, the Flash Protection Boundary shall be 4.0 ft, based on the product of clearing times of 6 cycles (0.1 second) and the available bolted fault current of 50 kA or any combination not exceeding 300 kA cycles (5000 ampere seconds). For clearing times and bolted fault currents other than 300 kA cycles, or under engineering supervision, the Flash Protection Boundary shall alternatively be permitted to be calculated in accordance with the following general formula where:

$D_c$  = distance in feet from an arc source for a second-degree burn

$MVA_{bf}$  = bolted fault capacity available at point involved (in mega volt-amperes)

$MVA$  = capacity rating of transformer (mega volt-amperes). For transformers with MVA ratings below 0.75 MVA, multiply the transformer MVA rating by 1.25

$t$  = time of arc exposure (in seconds)

At voltage levels above 600 volts, the Flash Protection Boundary is the distance at which the incident energy equals 5 J/cm<sup>2</sup> (1.2 cal/cm<sup>2</sup>). For situations where fault-clearing time is 0.1 second (or faster), the Flash Protection Boundary is the distance at which the incident energy level equals 6.24 J/cm<sup>2</sup> (1.5 cal/cm<sup>2</sup>).

(A) Protective Clothing and Personal Protective Equipment for Application with a Flash Hazard Analysis. Where it has been determined that work will be performed within the Flash Protection Boundary by 130.3(A), the flash hazard analysis shall determine, and the employer shall document, the incident energy exposure of the worker (in calories per square centimeter). The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Flame-resistant (FR) clothing and personal protective equipment (PPE) shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the distance at which the incident energy was determined. As an alternative, the PPE requirements of 130.7(C)(9) shall be permitted to be used in lieu of the detailed flash hazard analysis approach described in 130.3(A).

*FPN: For information on estimating the incident energy, see Annex D.*

#### 400.11 Flash Protection.

Switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

## 29 CURRENT FEDERAL REGISTER (29 CFR)

### 1910.132 General Requirements

**1910.132(a):** Application. Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological

hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.

**1910.132(b):** Employee-owned equipment. Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.

**1910.132(c):** Design. All personal protective equipment shall be of safe design and construction for the work to be performed.

**1910.132(d):** Hazard assessment and equipment selection.

**1910.132(d)(1):** The employer shall assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment (PPE). If such hazards are present, or likely to be present, the employer shall:

**1910.132(d)(1)(i):** Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment;

**1910.132(d)(1)(ii):** Communicate selection decisions to each affected employee; and,

**1910.132(d)(1)(iii):** Select PPE that properly fits each affected employee.

**Note:** Non-mandatory appendix B contains an example of procedures that would comply with the requirement for a hazard assessment.

**1910.132(d)(2):** The employer shall verify that the required workplace hazard assessment has been performed through a written certification that identifies the workplace evaluated; the person certifying that the evaluation has been performed; the date(s) of the hazard assessment; and, which identifies the document as a certification of hazard assessment.

**1910.132(e):** Defective and damaged equipment. Defective or damaged personal protective equipment shall not be used.

**1910.132(f):** Training.

**1910.132(f)(1):** The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following:

**1910.132(f)(1)(i):** When PPE is necessary;

**1910.132(f)(1)(ii):** What PPE is necessary;

**1910.132(f)(1)(iii):** How to properly don, doff, adjust, and wear PPE;

**1910.132(f)(1)(iv):** The limitations of the PPE; and,

**1910.132(f)(1)(v):** The proper care, maintenance, useful life and disposal of the PPE.

**1910.132(f)(2):** Each affected employee shall demonstrate an understanding of the training specified in paragraph (f)(1) of this section, and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.

**1910.132(f)(3):** When the employer has reason to believe that any affected employee who has already been trained does not have the understanding and skill required by paragraph (f)(2) of this section, the employer shall retrain each such employee. Circumstances where retraining is required include, but are not limited to, situations where:

**1910.132(f)(3)(i):** Changes in the workplace render previous training obsolete; or

**1910.132(f)(3)(ii):** Changes in the types of PPE to be used render previous training obsolete; or

**1910.132(f)(3)(iii):** Inadequacies in an affected employee's knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill.

**1910.132(g):** Paragraphs (d) and (f) of this section apply only to 1910.133, 1910.135, 1910.136, 1910.138, and 1910.140. Paragraphs (d) and (f) of this section do not apply to 1910.134 and 1910.137.

**1910.132(h):** Payment for protective equipment.

**1910.132(h)(1):** Except as provided by paragraphs (h)(2) through (h)(6) of this section, the protective equipment, including personal protective equipment (PPE), used to comply with this part, shall be provided by the employer at no cost to employees.

**1910.132(h)(2):** The employer is not required to pay for non-specialty safety-toe protective footwear (including steel-toe shoes or steel-toe boots) and non-specialty prescription safety eyewear, provided that the employer permits such items to be worn off the job-site.

**1910.132(h)(3):** When the employer provides metatarsal guards and allows the employee, at his or her request, to use shoes or boots with built-in metatarsal protection, the employer is not required to reimburse the employee for the shoes or boots.

**1910.132(h)(4):** The employer is not required to pay for:

**1910.132(h)(4)(i):** The logging boots required by 29 CFR 1910.266(d)(1)(v);

**1910.132(h)(4)(ii):** Everyday clothing, such as long-sleeve shirts, long pants, street shoes, and normal work boots; or

**1910.132(h)(4)(iii):** Ordinary clothing, skin creams, or other items, used solely for protection from weather, such as winter coats, jackets, gloves, parkas, rubber boots, hats, raincoats, ordinary sunglasses, and sunscreen.

**1910.132(h)(5):** The employer must pay for replacement PPE, except when the employee has lost or intentionally damaged the PPE.

**1910.132(h)(6):** Where an employee provides adequate protective equipment he or she owns pursuant to paragraph (b) of this section, the employer may allow the employee to use it and is not required to reimburse the employee for that equipment. The employer shall not require an employee to provide or pay for his or her own PPE, unless the PPE is excepted by paragraphs (h)(2) through (h)(5) of this section.

**1910.132(h)(7):** This paragraph (h) shall become effective on February 13, 2008. Employers must implement the PPE payment requirements no later than May 15, 2008.

**Note to 1910.132(h):** When the provisions of another OSHA standard specify whether or not the employer must pay for specific equipment, the payment provisions of that standard shall prevail.