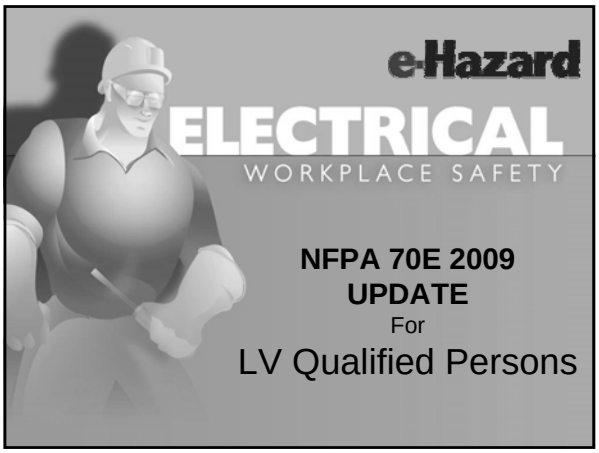
OSC | 09
Ohio Safety Congress & Expo

NFPA 70E and OSHA update, Parts one and two

April 2, 2009

Sessions SCH435 and SCH436

Presented by Drake Drobnick



Safety Facts

ELECTRICAL WORKPLACE SAFETY

Why be concerned about electrical safety?

- Personal safety
- Safety for your fellow workers
- Destruction of equipment/downtime
- Comply with applicable regulations

Prevent Recurrence

ELECTRICAL WORKPLACE SAFETY

Safety Facts

ELECTRICAL WORKPLACE SAFETY

- Average of 4,000 non-disabling and 3,600 disabling electrical contact injuries annually in the United States.
- One person is electrocuted in the workplace every day.
- Electrocutions are the fourth leading cause of traumatic occupational fatalities.
- Over 2,000 workers are sent to burn centers each year with electrical burns.

Safety Facts

ELECTRICAL WORKPLACE SAFETY

- An electrical industry 10-year study of 120,000 workers
- 125 injuries per year
- 77% electrical arc injuries
- 21% permanent disabilities
- 2.4% fatalities

Based on ED France data, IEEE Presentation from M. Capelli-Schellpfeffer, M.D. Electrical Trauma Research Program (University of Chicago)

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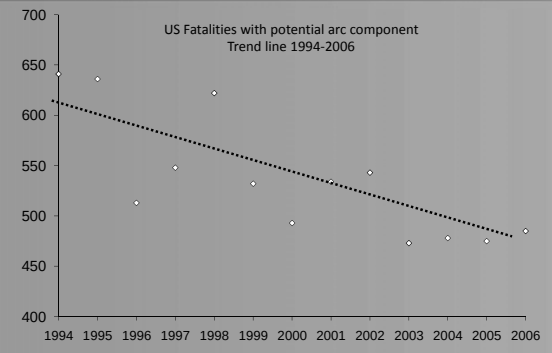
Safety Facts

ELECTRICAL WORKPLACE SAFETY



Statistics from BLS website,. Analysis by Hugh Hoagland ArcWear.com. To see calculations, visit www.arcwear.com/stats.mht

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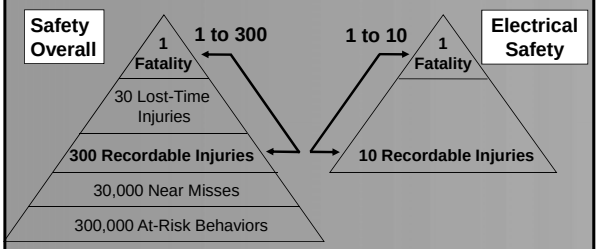
Safety Facts

ELECTRICAL WORKPLACE SAFETY



Flash Hazard PPE – Clothing

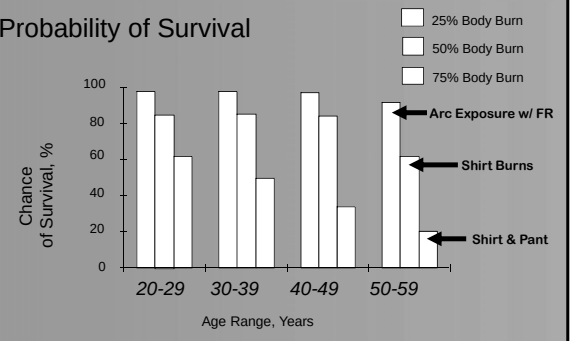
ELECTRICAL WORKPLACE SAFETY

The right stuff makes a difference

Flash Hazard PPE – Clothing

ELECTRICAL WORKPLACE SAFETY

Probability of Survival



Source: American Burn Association (1991-1993 Study)

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Flash Hazard PPE – Clothing

ELECTRICAL WORKPLACE SAFETY

Costs of FR vs. Non-FR: A Real Example

Two Accidents Before FR		Two Accidents After FR
	Paid & Reserve	Paid & Reserve
Medical	$812,677	$32,707
Indemnity	$773,613	$6,035
Vocational	$9948	$1,903
Expenses	$931	$36
Total	**$1,597,229**	**$44,682**
Medical	$309,571	$9,213
Indemnity	$49,369	$1,890
Vocational	$9,999	$1,195
Expenses	$20	$10
Total	**$368,992**	**$12,309**

Source: PECO Presentation by Bill Mattiford, PES-IEEE Seminar
Accident 1: 7/29/93 Accident 2: 7/12/94 Accident 3: 6/1/95 Accident 4: 6/1/95
Accidents in FR were lightweight FR uniform. Actual results may vary.

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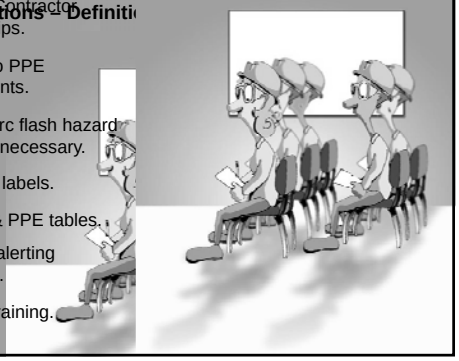
What's New is 70E 2009

ELECTRICAL WORKPLACE SAFETY

- Employer/Contractor Relationships.
- Changes to PPE Requirements.
- When an arc flash hazard analysis is necessary.
- Mandatory labels.
- New task & PPE tables.
- Additional alerting techniques.
- Required training.



NFPA 70E 2009

ELECTRICAL WORKPLACE SAFETY

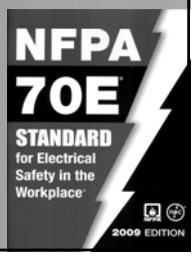
Three-part structure:

Chapter 1 – Safety-related work practices

Chapter 2 – Safety-related maintenance requirements

Chapter 3 – Safety requirements for special equipment

REMOVED Chapter 4 – Installation Safety Requirements. Part of NEC.



Regulations & Standards

ELECTRICAL WORKPLACE SAFETY

Strategies Embedded in NFPA 70E (2009)

- Electrically safe work condition
- Training
- Planning
- PPE
- 70E assumes a code-compliant installation.

The focus of this training program is 70E Chapter One, and also meets the requirements of OSHA 1910, Subpart S 331-335.

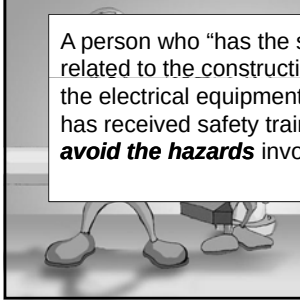
Definition of a Qualified Person

ELECTRICAL WORKPLACE SAFETY

What is a qualified person…

A person who "has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training ***to recognize and avoid the hazards*** involved."

NFPA 70E, Article 100, pg 13



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low voltage qualified.

Responsibilities to Contractors

ELECTRICAL WORKPLACE SAFETY

Relationships with Contractors & Outside Personnel

Host employer responsibilities:

- To alert contractor to known hazards covered by 70E.
- Adequate information about installation so contractor can make informed safety assessments.
- Report contractor employee safety violations to contractor.

NFPA 70E 110.5

Responsibilities to Contractors

ELECTRICAL WORKPLACE SAFETY

Relationships with Contractors & Outside Personnel

NFPA 70E 110.5

Contractor responsibilities:

- To inform employees of all potential hazards specific to the installation and to require they follow all required safe work practices.
- To alert host employer of any unique hazards presented by contractor's work.
- To inform host employer of any hazards encountered that host employee did not mention.
- To report measures taken to correct any violations of required safe work practices.

Electrical Hazards - Shock

ELECTRICAL WORKPLACE SAFETY

No Permit Required for:

- ***Visual inspection (if not crossing restricted boundary).***
- Testing (voltage, current, phasing, & system tuning).
- Circuit identification.
- Troubleshooting.

NFPA 70E 130.1(B)(3)

"Standing" work permits allowed if written and management approved.

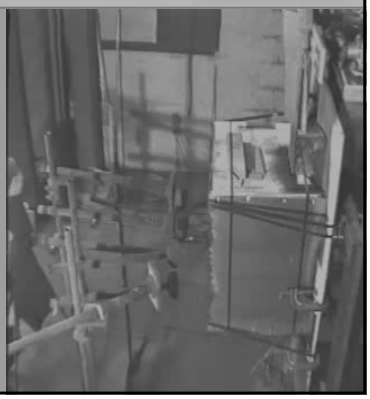
TESTING IS TOUCHING.

Electrical Hazards – AFH

ELECTRICAL WORKPLACE SAFETY

Arc in a Box

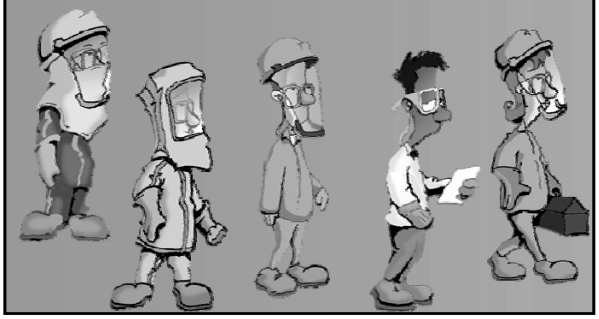
Energy can be two to twelve times greater when the arc is an *arc in a box* situation.



Flash Hazard PPE – Clothing

ELECTRICAL WORKPLACE SAFETY

Protective Clothing Systems



Flash Hazard PPE – Layering

ELECTRICAL WORKPLACE SAFETY

Layering Principles

NFPA 70E does not recognize non-FR layers as adding arc flash protection in HRC tables. Only FR layers can be counted toward the total protective calorie count.

Although layered FR garments may provide protection beyond the actual calorie count, only the arc rating values of individual layers is acceptable in the total count unless the system is tested.

NFPA 70E Annex M

HRC PPE Changes

ELECTRICAL WORKPLACE SAFETY

Category 0 – Non-igniting, non-melting

- Safety glasses
- ***Hearing protection***
- ***Leather gloves if rubber insulating gloves are not required for shock protection***
- Non-melting, flammable clothing with 4.5 oz/yd^2

Minimum requirements – your location may require additional PPE.

HRC PPE Changes

ELECTRICAL WORKPLACE SAFETY

Category 1 – 4 cal/cm²

- Safety glasses
- ***4 cal/cm² arc-rated face shield or flash hood***
- Hearing protection
- ***Leather gloves if rubber insulating gloves are not required for shock protection***
- Hard hat
- Leather work shoes, as needed

Flash Hazard PPE – Clothing

ELECTRICAL WORKPLACE SAFETY

Face shields have limits

Faceshield w/Balaclava Hood

ELECTRICAL WORKPLACE SAFETY

Arc Rating (ATPV) = 10.9 cal/cm²

Back Exposure

Balaclava and shield No Safety Glasses

ELECTRICAL WORKPLACE SAFETY

Arc Rating (ATPV) = 30 cal/cm²

60 Degree Angle Exposure

Balaclava, shield, no safety glasses

ELECTRICAL WORKPLACE SAFETY

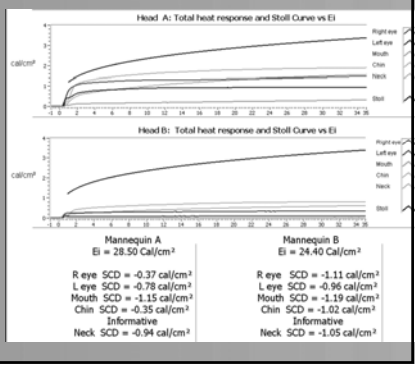
Balaclava and shield WITH Safety Glasses

ELECTRICAL WORKPLACE SAFETY

Balaclava and shield WITH Safety Glasses

ELECTRICAL WORKPLACE SAFETY

- Prevented all burns on all sensors.
- Could justify using a balaclava, shield and safety glasses for HRC 2* and possibly HRC 3 or more depending on shield and balaclava



HRC PPE Changes

ELECTRICAL WORKPLACE SAFETY

Category 2 – 8 cal/cm²

- Safety glasses
- 8 cal/cm² arc-rated shirt and pants or coveralls
- Hard hat (Class E)
- 8 cal/cm² arc-rated face shield or hood
- Hearing protection
- Leather gloves if rubber insulating gloves are not required for shock protection
- Leather work shoes

Natural fiber under-layers no longer included in system calorie count.

HRC PPE Changes

ELECTRICAL WORKPLACE SAFETY

Category 3 – 25 cal/cm²

Clothing levels must equal the calorie count for the hazard risk category.

25 cal/cm² system:

Safety glasses	Hard hat (Class E)
Hearing protection	Leather work shoes

Arc-rated gloves if rubber insulating gloves are not required for shock protection

Total of 25 cal/cm² arc-rated protection: Shirt and pants, coveralls, arc flash suit, or any combination.

25 cal/cm² arc-rated flash hood

HRC PPE Changes

ELECTRICAL WORKPLACE SAFETY

Category 4 – 40 cal/cm²

Clothing levels must equal the calorie count for the hazard risk category.

40 cal/cm² system:

Safety glasses	Hard hat (Class E)
Hearing protection	Leather work shoes

Arc-rated gloves if rubber insulating gloves are not required for shock protection

Total of 40 cal/cm² arc-rated protection: Shirt and pants, coveralls, arc flash suit, or any combination.

40 cal/cm² arc-rated flash hood

Flash Hazard PPE – Clothing

ELECTRICAL WORKPLACE SAFETY

Simplified and Fool-proofed PPE program – Use the *Common Approach* (Appendix H)

Category 2 – 8 cal/cm²

Either

HRC 2

Or

HRC4

Category 4 – 40 cal/cm²

Flash Hazard PPE – Clothing

ELECTRICAL WORKPLACE SAFETY

100% Cotton vs. HRC 2 Clothing

Indura® UltraSoft® Shirt Indura® Denim Jean vs. Non-FR Cotton

Flash Hazard PPE – Clothing

ELECTRICAL WORKPLACE SAFETY

FR over Poly Cotton –

Be careful what you put beneath FR

Florida 480V Accident

ELECTRICAL WORKPLACE SAFETY

Electrical Hazards – AFH

ELECTRICAL WORKPLACE SAFETY

Default Flash Protection Boundary

A 48” boundary may be used for basic systems:

- 50 to 600 volts maximum.
- Up to 50kA available and ***2-cycle*** clearing time.
- Other combinations up to ***100kA*** cycles.
- Calculations are permitted.

NFPA 70E 130.3(A)

Hazard Assessment

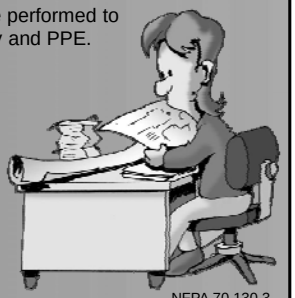
ELECTRICAL WORKPLACE SAFETY

Flash Hazard Analysis Required

Flash hazard analysis must be performed to determine protection boundary and PPE.

Must be reviewed a minimum of every five years. Updates required if major modifications or renovations.

Must consider effects of overcurrent protective devices and opening times.



NFPA 70 130.3

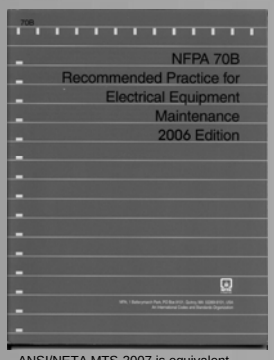
Regulations & Standards

ELECTRICAL WORKPLACE SAFETY

NFPA 70B requires power circuit breakers be ***maintained & calibrated*** on an interval required by the manufacture or every three to five years.

Breaker maintenance and calibration are critical to arc flash protection.

NFPA 70E 205.3 Overcurrent Device



ANSI/NETA MTS-2007 is equivalent.

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Hazard Assessment

ELECTRICAL WORKPLACE SAFETY

Exceptions to Performing an Analysis

Exception #1:

- **Circuit is rated at 240 volts or less,** AND,
- **Circuit is supplied by one transformer,** AND,
- **Transformer supplying circuit is rated at less than 125kVA.**

Exception #2: The following default tables may be used in lieu of an analysis if you meet the table notes:

- 130.7(C)(9) Hazard/Risk Category Classifications.
- 130.7(C)(10) Protective Clothing and PPE.
- 130.7(C)(11) Protective Clothing Characteristics.

NFPA 70 130.3

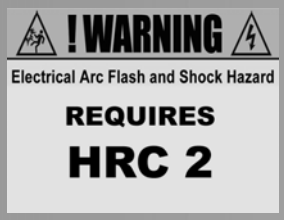
Hazard Assessment

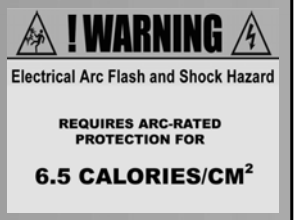
ELECTRICAL WORKPLACE SAFETY

Arc Flash Hazard Labels

NFPA 70 130.3 (C)

Equipment must be field labeled with labels displaying either the incident energy level or the required PPE.





ELECTRICAL WORKPLACE SAFETY

WARNING

Arc Flash and Shock Hazard

~~Arc Flash Protection~~
~~48'' Flash Protection Boundary~~
5 Cal/Cm² ~~@ 18 inches~~

~~Shock Protection~~
~~480 VAC Shock Hazard Exposure~~

Use Class "00" Insulated Gloves with Leather Protectors, 8 Cal/Cm² FR Clothing, Hard Hat/Face Shield

Equipment Name:

Table Changes

ELECTRICAL WORKPLACE SAFETY

Table 130.7(C)(9) Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Panelboards or Other Equipment Rated 240 V and Below — Note 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary			
Circuit breaker (CB) or fused switch operation with covers on			
CB or fused switch operation with covers off			
Work on energized electrical conductors and circuit parts, including voltage testing			
Remove/install CBs or fused switches			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)			
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) — Note 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch operation with covers on	0	N	N

Panelboards Rated 240 V and Below — Notes 1 and 3
Circuit breaker (CB) or fused switch operation with covers on
CB or fused switch operation with covers off
Work on energized parts, including voltage testing
Remove/install CBs or fused switches
Removal of boltsd covers (to expose bare, energized parts)
Opening hinged covers (to expose bare, energized parts)

Table Changes

ELECTRICAL WORKPLACE SAFETY

General Notes (applicable to the entire table):
(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools.*
(c) Y = yes (required), N = no (not required).
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (½ cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.
Specific Notes (as referenced in the table):
1. Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.
2. Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.
3. Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time.
4. Maximum of 35 kA short circuit current available; maximum of up to 0.5 sec (30 cycle) fault clearing time.

Table Changes

ELECTRICAL WORKPLACE SAFETY

Table 130.2(C) Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection (All dimensions are distance from energized electrical conductor or circuit part to employee.)

(1)	(2) Limited Approach Boundary[1]	(3)	(4)	(5)
Nominal System Voltage Range, Phase to Phase[2]	Exposed Movable Conductor[3]	Exposed Fixed Circuit Part	Restricted Approach Boundary[1]; Includes Inadvertent Movement Adder	Prohibited Approach Boundary[1]
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	Avoid contact	Avoid contact
301 to 750	3.05 m (10 ft 0 in.)	1.07 m (3 ft 6 in.)	304.8 mm (1 ft 0 in.)	25.4 mm (0 ft 1 in.)
751 to 15 kV	3.05 m (10 ft 0 in.)	1.53 m (5 ft 0 in.)	660.4 mm (2 ft 2 in.)	177.8 mm (0 ft 7 in.)
15.1 kV to 36 kV	3.05 m (10 ft 0 in.)	1.83 m (6 ft 0 in.)	787.4 mm (2 ft 7 in.)	254 mm (0 ft 10 in.)
36.1 kV to 46 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	838.2 mm (2 ft 9 in.)	431.8 mm (1 ft 5 in.)
46.1 kV to 72.5 kV	3.05 m (10 ft 0 in.)	2.44 m (8 ft 0 in.)	1.0 m (3 ft 3 in.)	660 mm (2 ft 2 in.)
72.6 kV to 121 kV	3.25 m (10 ft 8 in.)	2.44 m (8 ft 0 in.)	1.29 m (3 ft 4 in.)	838 mm (2 ft 9 in.)
138 kV to 145 kV	3.36 m (11 ft 0 in.)	3.05 m (10 ft 0 in.)	1.35 m (3 ft 10 in.)	1.02 m (3 ft 4 in.)
161 kV to 169 kV	3.56 m (11 ft 8 in.)	3.56 m (11 ft 8 in.)	1.29 m (4 ft 3 in.)	1.14 m (3 ft 9 in.)
230 kV to 242 kV	3.97 m (13 ft 0 in.)	3.97 m (13 ft 0 in.)	1.71 m (5 ft 8 in.)	1.57 m (5 ft 2 in.)
345 kV to 362 kV	4.68 m (15 ft 4 in.)	4.68 m (15 ft 4 in.)	2.77 m (9 ft 2 in.)	2.79 m (8 ft 8 in.)
500 kV to 550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.61 m (11 ft 10 in.)	3.54 m (11 ft 4 in.)
765 kV to 800 kV	7.24 m (23 ft 9 in.)	7.24 m (23 ft 9 in.)	4.84 m (15 ft 11 in.)	4.7 m (15 ft 5 in.)

Note: For Arc Flash Protection Boundary, see 130.3(A).
[1] See definition in Article 100 and text in 130.2(D)(2) and Annex C for elaboration.
[2] For single-phase systems, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.
[3] 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.

Table Changes

ELECTRICAL WORKPLACE SAFETY

Table 130.7(C)(10) Protective Clothing and Personal Protective Equipment (PPE) Matrix

Protective Clothing and Equipment	Protective Systems for Hazard/Risk Category					
Hazard/Risk Category Number	–1 (Note 3)	0	1	2	3	4
FR Protective Equipment						
a. Flash suit jacket (multilayer)						X
b. Flash suit pants (multilayer)						X
c. Head protection						
1. Hard hat			X	X	X	X
2. FR hard hat liner					AR	AR
d. Eye protection		—	—	—	—	—
1. Safety glasses	X	X	X	AL	AL	AL
2. Safety goggles				AL	AL	AL
e. Face and head area protection		—	—	—	—	—
1. Arc-rated face shield, or flash suit hood				X (Note 8)		
2. Flash suit hood					X	X
3. Hearing protection (ear canal inserts)				X (Note 8)	X	X
f. Hand protection			—	—	—	—
Leather gloves (Note 2)			AN	X	X	X
g. Foot protection						
Leather work shoes			AN	X	X	X

Alerting Techniques

ELECTRICAL WORKPLACE SAFETY

Use Alerting Techniques on Look-Alike Equipment

When a piece of equipment in an electrically safe work condition is with other similar, still energized equipment,

The de-energized equipment must be identified with one or more of the alerting techniques described in 130.7(E) (1), (2), or (3).

NFPA 70E 130.7(E)

Exposed to Electrical Hazards

ELECTRICAL WORKPLACE SAFETY

Alerting Techniques

NFPA 70E 130.7(E)
OSHA 1910.335 (b)

Safety signs & tags –

- Warn about electrical hazards.
- Must meet ANSI Z535.

Barricades and signs –

- Used when signs are not adequate or exposed, live parts are present.
- Placed at the limited approach boundary or arc flash boundary, which ever greater.

Attendants –

- Used when signs and barricades do not provide sufficient warning.

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Training for All Personnel

ELECTRICAL WORKPLACE SAFETY

Levels of Training

- Adequate for the tasks involved.
- All persons must be trained in any safety-related practices necessary for their safety.
- To work inside the limited approach boundary, an unqualified person must be trained on:
  - Hazards involved and potential injuries.
  - PPE required.
  - Distances to maintain.
  - Other safe work practices related to task.

NFPA 70E 110.6

Training for Qualified Personnel

ELECTRICAL WORKPLACE SAFETY

Qualified Person must be trained on:

- Distinguishing exposed, energized conductors and parts.
- Determining nominal voltages.
- Approach distances for exposed voltages.

- Recognizing the degree & extent of hazards, PPE and job planning to safely perform task.
- ***Selection of a proper voltage detector and safely using it to verify absence of voltage***.
- ***Annual CPR training.***

NFPA 70E 110.6
OSHA 1910.332(b)

Training for Qualified Personnel

ELECTRICAL WORKPLACE SAFETY

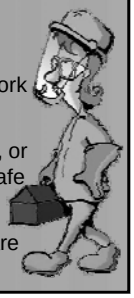
Qualified Person must be trained on:

NFPA 70E 110.6
OSHA 1910.332(b)

- Tasks performed less than once per year.

Retraining required:

- Supervision or annual inspection indicate employees not complying with required work practices.
- New technology, new types of equipment, or changes in procedures require different safe work practices.
- If safe work practices not normally used are required.



Training for Qualified Persons

ELECTRICAL WORKPLACE SAFETY

Types of training

- Classroom, and/or
- On-the-job (OJT).

Documentation Required

- ***Demonstrated proficiency.***
- Name and dates training conducted.
- Maintained for duration of employment.

NFPA 70E 110.6 (D)

Emergency Response Training

- **Qualified employees**
- **First-aid (1910.151)**
- **BBP (1910.1030)**
- **CPR/AED**

NESC

- National Electric Safety Code
- Updated Regularly
- ANSI C-2
- NEC is ANSI C-3
- Safety for Utilities

NESC Hazard Assessment

- Clothing effective as of January 1, 2009
- Arc Flash Assessment required
- If "exposure greater than 2 cal/cm²
  - employer shall require employees to wear clothing …that has an effective arc rating not less than the anticipated level of arc energy
- Secondary Systems require
  - 4 cal/cm² PPE
  - "engineering controls" due to high energies
- Exemption for "greater hazards" not well defined

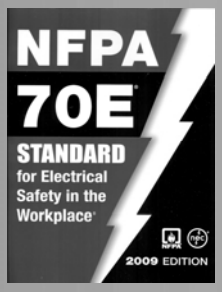
Things to do, Review

ELECTRICAL WORKPLACE SAFETY

- Conduct Hazard Analysis/Selective Coordination study
- Determine a hazard mitigation strategy
- Update Single Line Drawings
- Develop Electrical Safety Program
- Select PPE
- Train employees
- Label equipment
- Audit for compliance
- Review program annually

Refer to the Standards

ELECTRICAL WORKPLACE SAFETY



If unsure, look it up!

Safety Never Ends

ELECTRICAL WORKPLACE SAFETY

Contact Information

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