



**Dodge the arc –
NFPA 70E compliance**
344

**Steve Abbott, President
Stark Safety Consultants**

Thursday, April, 1 2010 1 to 2 p.m.



Steven J. Abbott
President – Stark Safety Consultants

- * 18 years as trainer of electrical safe work practices
- * National training partner :“NFPA 70E TTT Seminar”
National Joint Electrical Apprenticeship committee
- * Board Officer / Professional member:
American Society of Safety Engineers (McKinley Chapter)



Why the need for electrical safe work practices?

1. Electrocution - 4th highest cause of industrial fatalities – Over 600 deaths
2. Over 30,000 non-fatal electrical shock accidents occur each year
3. N.I.O.S.H. survey between 1992 – 2001: 17,000 injuries were caused by electric arc flash burns.
4. During that span – An average of 1,000 burn victims sent to burn centers every year.
5. Survey of 1,200 electricians by NFPA found 97% had experienced a shock at one time or more in the workplace.
6. The final cost to employers and their insurers for a single, serious injury can approach \$10 million.
7. It's the law!



What / who regulates Electrical hazards?

Federal Regulations
O.S.H.A. 1910 & 1926

Industry Standards

NFPA 70B Recommended Practice for Electrical Equipment Maintenance
ANSI, NIOSH, and ASTM

NEC The National Electrical Code
NFPA 70E Standard For Electrical Safety in the Workplace

Best Practices

“Left hand rule” Use of arc flash software for calculations IEEE 1584



How does OSHA use 70E?

OSHA General Duty Clause:

(5(a)(1)) Each employer --

Shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;



OSHA 1910 Sub Part S:
Just to name a few.....

Has been in place since August 6th 1990!

1910.332(b)(3)
Additional requirements for qualified persons.
(i.e. those permitted to work on or near exposed energized electrical conductors or parts:

1910.332(b)(3)(ii)
The skills and techniques necessary to determine the nominal voltage of exposed live parts...

1910.335(a)(1)(i). requires use of PPE to guard workers against electrical hazards....

1910.333(a)(1)
"Deenergized parts." Live parts to which an employee may be exposed shall be de-energized before the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

Changes in 2009 NFPA 70E

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Article 130.1 Justification for Work

Live parts to which an employee may be exposed shall be placed into an electrically safe work condition before the employee works **within the Limited Approach Boundary of those conductors or parts**, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

We are talking about anything 50 volts and above

Approach Boundaries to Electrical Hazards

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Flash Protection Boundary

Art. 130.2(C)
50v-750v--3ft. 6"

Limited Approach Boundary

Warning label provides boundary information

Justification for Work

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NFPA 70E Article 130.1:

FPN No.1:

Examples of increased or additional hazards include, but are not limited to:

- Interruption of life support equipment,
- Deactivation of emergency alarm systems,
- Shutdown of hazardous location ventilation equipment.

Justification for Work

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NFPA 70E Article 130.1:

FPN No. 2:

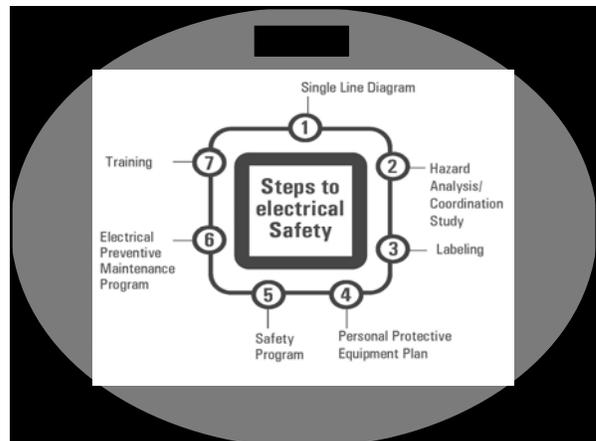
Examples of work that might be performed on or near exposed energized electrical conductors or circuit parts because of infeasibility due to equipment design or operational limitations include:

- Performing diagnostics and testing.
- Equipment start-up
- Troubleshooting
- Work on circuits that form an integral part of continuous process that would otherwise need to be completely shutdown in order to permit work on one circuit or piece of equipment

Justification?

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Infeasible or.....Inconvenient???





110.7 Electrical Safety Program

110.7(A), in part

- The employer shall implement and document an overall electrical safety program that directs activity appropriate for...
 - Voltage
 - Energy level
 - Circuit conditions.

Electrical hazards
Shock
Arc flash
Arc blast



110.7 Electrical Safety Program

Mistakes to avoid

- Focusing on compliance instead of safety
- Creating a program that "Avoids" making difficult decisions
 - Infeasible VS Inconvenient
 - Canned program VS site /Company specific
- Creating unrealistic objectives / procedures ("No hot work")
- Relying on electricians experience & training as a substitute for safe work practices and proper PPE.
- Considering the NFPA 70E document as your electrical safety program

Where do they fit in?

1. Qualified
(Authorized)



2. Qualified (Task Specific)



3. Unqualified:



ARTICLE 110.6 TRAINING REQUIREMENTS

Qualified Person

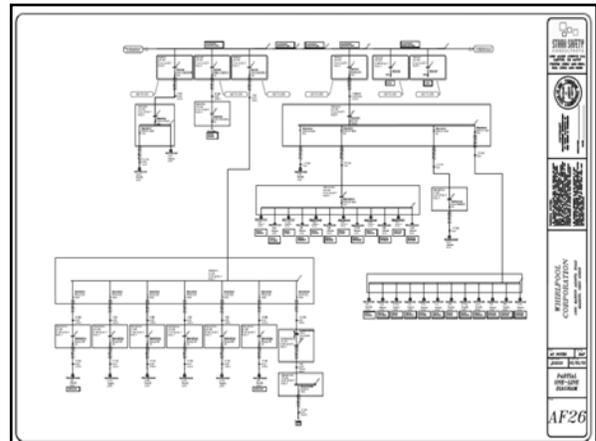
- LOTO
- How to create an electrical safe work condition
- Performing an electrical hazards analysis (Shock & flash hazard analysis)
- Determining protection boundaries
- Label – How to read
- Test equipment.
- Selecting appropriate PPE
 - Arc-flash protection (FR)
 - Insulating and shielding materials
 - Insulated tools

A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others



ARTICLE 110.6 TRAINING REQUIREMENTS

Unqualified persons are prohibited from entering areas accessible only to qualified persons unless the equipment is in an electrically safe work condition.





Determining PPE

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© *NFPA 70E* Section 130.7(C):
 Methods to determine protective equipment:

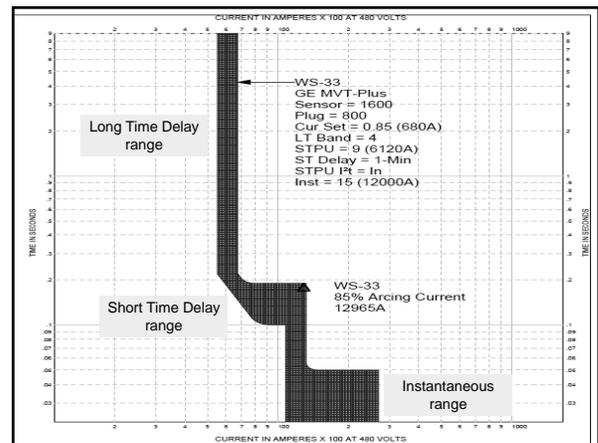
- Incident energy analysis
- Hazard/risk category (HRC)

Refers back to 130.3(B)

INCIDENT ENERGY

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Based on:
 Available fault current
 Distance from arc
 Clearing time



How do you know what you need?

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1. In house vs. Outsource:
2. Ask for qualifications
3. Ask for references.
4. Watch the description on who is doing data collection.
5. Hazard reduction recommendations should be INCLUDED.
6. Ensure that you are getting what you need first - then get the best price

Hazard/Risk Categories

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When selected in lieu of the arc flash hazard analysisTable 130.7(C)(9) shall be used to determine the hazard/risk category for a task.

A flash hazard analysis shall be required in accordance with 130.3.....IF:

1. Task is not listed
2. For power systems with > assumed short-circuit current
3. Longer than the assumed fault clearing times

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

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Panel boards or Other Equipment Rated 240 V and Below
* Note 1: Max - 25 kA short circuit current available; max - 0.03 sec (2 cycle) fault clearing time.

Task	Hazard Risk	V-rated Gloves	V-rated Tools
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
Opening hinged covers (to expose bare, energized electrical conductors & circuit parts)	1	N	N
Work on energized parts, including voltage testing.	1	Y	Y

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Changes in 2009 NFPA 70E

130.3(C) [New]:

- Equipment Labeling.

Equipment shall be field marked with a label containing the available incident energy or required level of PPE.

ANSI Z535.4 Product Safety Signs and Labels, provides guidelines for the design of safety signs and labels for application to products.

 WARNING	 WARNING
Arc Flash and Shock Hazard Appropriate PPE Required	Arc Flash and Shock Hazard Appropriate PPE Required
13' - 0" 29.0 34 Flash Hazard Boundary cal/cm ² Incident Energy at 18 Inches PPE Level Appropriate FR Apparel Required	PPE Level #4 at 18 Inches
0.48 3' - 6" KV Shock Hazard with Cover Removed Limited Approach Boundary Class 00 Voltage Gloves	0.48 3' - 6" KV Shock Hazard with Cover Removed Limited Approach Boundary Class 00 Voltage Gloves
DEVICE ID: WA2A1 (Protected By: WA2) Additional Information Available with Analysis Reports Analysis Date: 08.21.09 Stark Safety Consultants 1.866.923.7922	DEVICE ID: WA2A1 (Protected By: WA2) Additional Information Available with Analysis Reports Analysis Date: 08.21.09 Stark Safety Consultants 1.866.923.7922

⚠ DANGER ⚠
Arc-Flash Hazard and Shock Hazard

12 - 11.2" - 18" Flash Protection Boundary
14.5 cal/cm² - Incident Energy Flash Hazard at 18 inches

Appropriate PPE Required for both Arc-Flash and Shock Hazards:
Safety Glasses/Goggles, Hard Hat, Face Shield, Hearing Protection, Class 00 Voltage Gloves, Leather Glove Protection, Voltage Proof Tools, Leather Shoes, Cotton Underwear, FR Long Sleeve Shirt, FR Long Pants, Multi-layer Hardhat

3600 V - Shock Hazard with covers open
3" - 6" - Limited Approach Boundary
12.5" - Restricted Approach Boundary
9" - 12" - Prohibited Approach Boundary

3600 V - 1.0
PROV OF CIRCULAR

WARNING
Arc Flash and Shock Hazard
Appropriate PPE Required

FLASH PROTECTION
Flash Hazard at 18 inches
Min. Arc Rating: 36 cal/cm²
Flash Protection Boundary: 142 inch
Glove Class: 00

SHOCK PROTECTION
Shock Hazard when cover is removed 480 VAC
Limited Approach: 42 inch
Restricted Approach: 12 inch
Prohibited Approach: 1 inch

Category 4
• FR Shirt & Pants + Multi Layer Flash Suit

OCTOBER 2007

⚠ DANGER ⚠
600 V AC Arc Flash and Shock Hazard

5.67 cal/cm² (Class 1) - Limited Approach (Qualified Personnel Only)
28.0 cal/cm² (Class 2) - Restricted Approach (PPE Required)
28.0 cal/cm² (Class 2) - Prohibited Approach (PPE Required)
5.67 cal/cm² (Class 1) - Flash Hazard Boundary (PPE Required)

Category 2: PPE Required (6.9 cal/sq cm)

Eye and Head: Safety glasses with side shields for eye and face protection
Body: FR work clothes (short or long sleeve) and safety shoes (FR safety shoes)
Prohibited for work on energized or de-energized electrical equipment
Head and Arms: Leather safety gloves - Class 00 Voltage Gloves
Ears: Hearing protection (earplugs, earmuffs) when working with tools and equipment

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- ## Labeling concerns
1. Label should not take the place of a safety policy /procedure
 2. Label should have only 1 working distance and 1 PPE requirement
 3. Label for worst possible scenario present
 4. Spacing on bus duct – must be able to read – refer to item #3
 5. How many labels per piece of equipment – avoid clutter
 6. Don't try to out smart the requirements - Understand them



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Why there are ratings on PPE

85% of all arc flash injuries are due to burnt clothing

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Table 130.7(C)(10)

HRC 0 No FR rating	HRC 1 Minimum 4 Cal/cm2	HRC 2 Minimum 8 Cal/cm2	HRC 3 Minimum 25 Cal/cm2	HRC 4 Minimum 40 Cal/cm2
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Annex H

“Simplified PPE approach”

HRC 2 Minimum 8 Cal/cm2	HRC 4 Minimum 40 Cal/cm2
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Changes in 2009 NFPA 70E

130.7(C)(3): Revised to include the requirement that hairnets or beard nets be non-melting and flame resistant.

130.7(C)(15): Revised to clarify that hardhat liners and hairnets must be arc rated FR material, if worn.

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Why is maintenance important?

Figure 1-1 Typical time-current characteristic of a circuit breaker

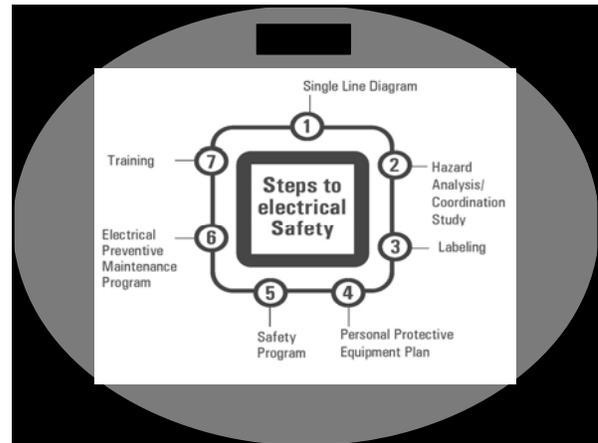
Would you really feel confident in any calculations done on this panel?



Changes in 2009 NFPA 70E

Chapter 2, Safety-Related Maintenance Requirements

- **200.1 Scope.**
- FPN: Refer to NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, and ANSI/NETA MTS-2007, Standard for Maintenance Testing Specification, for guidance on maintenance frequency, methods, and tests.



Frequently Asked Questions

1. What are they looking for (Regulatory / Legal)
 - a. Are you justified?
 - b. Conduct hazard assessment
 - c. Safety policy /procedures
 - d. PPE appropriate for the hazard
 - e. Training
2. How much does an arc flash “study” cost?
 - a. What is a study point?
 - b. Counting the study points
 - c. Methods for counting
 - d. Total cost: Approx. \$65 - \$200 per study point



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Arc Flash Analysis Process

1. Site assessment /Data Collection
2. System Modeling / Develop Single Line Diagram
3. Analysis
 - a. Short Circuit Calculations
 - b. Time Current Curve Evaluation – coordination study
 - c. Incident Energy Calculations
 - d. Flash Protection Boundary Calculations
4. Develop the Report and Recommendations for hazard reduction
5. Create Arc Flash Warning Labels / install labels
6. Maintaining accuracy of information