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# Pinpointing Electrical Hazard Risk

## Incident Energy Analysis & Auditing

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E-Hazard, LLC




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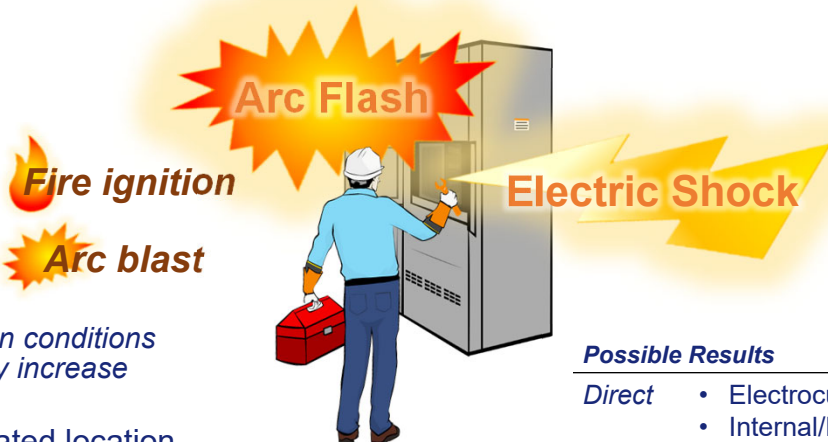
# Why is Risk Assessment a Concern?

## The Basics



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## Electrical Hazards



**Common conditions that may increase hazard:**

- Elevated location
- Confined space

**Possible Results**

|                 |  |
|-----------------|--|
| <b>Direct</b>   | <ul style="list-style-type: none"> <li>• Electrocution</li> <li>• Internal/External Burns</li> </ul> |
| <b>Indirect</b> | <ul style="list-style-type: none"> <li>• Falls</li> <li>• Smoke Inhalation</li> </ul>                |

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## By the Numbers

Annually, U.S. Averages

**+1,000**

Workers admitted to burn centers/hospitals for fire/flame and electrical burns\*

**1,900**

**electrical injuries** requiring days away from work

Top Occupations

**22%**

Installation, Maintenance, Repair

**43%**

Construction, Excavation

**In last 10 years\*\***

**+1,500**

Workplace fatalities from exposure to electricity

**Every other day**

**1**

**worker is electrocuted**



\* Based on NBR 2019 Report data \*\*2010-2019, bls.gov

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## OSHA Requirements

- The general duty clause requires workplaces to be **free from recognized hazards**
- Specific duty clauses require employers to comply with OSHA standards

### OSHA Specific Duty Clauses: Look it Up

- Deenergize in 1910.333(a)(1)
- “Other” work practices in 1910.333(a)(2)
- Electrical Protective Equipment in 1910.335(a)(1)(i)
  - Arc Flash clothing?



CODE OF FEDERAL  
REGULATIONS

#### Title 29 Labor

Parts 1900 to § 1910.999

Containing a codification of documents  
of general applicability and future effect

Published by the Office of the Federal Register  
National Archives and Records Administration  
Special Edition of the Federal Register

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## Best Practice Compliance Strategies



- Training
- Job Safety Planning
- Risk Assessment
- Engineering
- Electrically safe work condition
- PPE & Tools

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## What is Risk?

**Risk:** Combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard.

If you take a disposable lighter and put your palm in the hottest part of the flame for one second, you will receive about 1.2 calories per cm<sup>2</sup> — the onset of a second-degree burn (blister burn)



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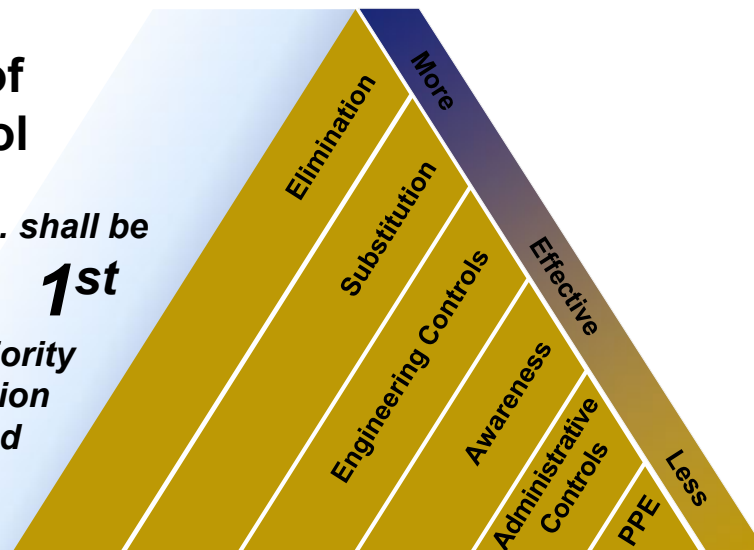
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## Addressing the Risks

### Hierarchy of Risk Control Methods

*... shall be  
**1st**  
priority  
in implementation  
of safety-related  
work practices*

NFPA 70E 110.1



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## What is Incident Energy? What Does Working Distance Mean?

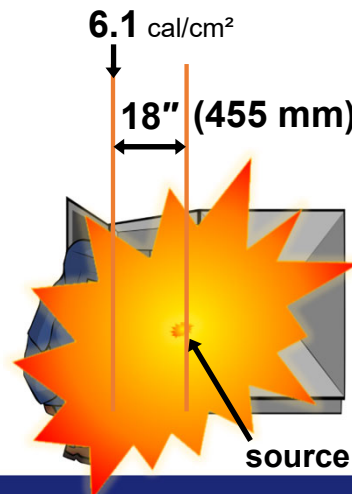
### Incident Energy (IE):

- Amount of energy impressed on a surface at certain distance from the source
- Generated during an electric arc event

### Working Distance:

- Distance between worker's face and chest area and a potential arc source

Example: IE =  $6.1 \text{ cal/cm}^2$   
at 18 inches (455 mm)



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## What Makes a Person Qualified...

NFPA 70E defines it as a two-part process:

"One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk."

*NFPA 70E, Article 100, pg. 13*

A person may be "task qualified" – qualified to perform a certain task or qualified to use certain equipment – but not be low voltage qualified.

**Only the employer can determine if someone is qualified.**

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## Skills & Knowledge Required to be a Qualified Person:



- Precautionary techniques used for working around the hazards
- Applicable electrical policies and procedures
- Proper use of PPE, including arc flash, insulating, and shielding materials
- Proper use of insulating tools and test equipment
- Distinguish exposed, energized conductors and circuits from other parts of equipment
- Determine nominal voltage

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## Skills & Knowledge Required to be a Qualified Person:



- Understand the approach distances and determining factors for shock and arc boundaries
- Understand decision making process necessary to be able to:
  - Perform job safety planning
  - Identify electrical hazards
  - Assess the associated risk
  - Select the appropriate risk control methods, including PPE

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# How Can Risk Be Reduced?

The Meat & Potatoes

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## Job Safety Planning Required

Must be completed by qualified person, documented and include:

- Job description with individual tasks
- Identify hazards associated with tasks
- Shock risk assessment
- Arc flash risk assessment
- Work procedures, special precautions, energy source controls
  - Energized repair work requires an Energized Electrical Work Permit (EEWP)

### Guidelines

- Identify
- Ask
- Check
- Know
- Think
- Prepare for emergencies

*NFPA 70E Annex I*

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## The Best Way to Reduce Hazard Exposure Is...



- Identify hazards
- Assess risks
  - Likelihood of occurrence
  - Potential severity
- Implement risk control methods
  - Remove or reduce possibility of contact through engineering controls
  - Establish mandatory safe work practices

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## Risk Assessment Musts

- Establish shock protection boundary
- Establish arc flash boundary
- Select appropriate PPE
- NFPA 70E Annex F provides guidelines for risk assessment



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# Methods for Arc Flash Risk Assessment

1<sup>st</sup>

Assess likelihood of arc flash incident using NFPA 70E Table 130.5(C)\*

2<sup>nd</sup>

## NFPA 70E Table Method

Follow guidelines in Tables 130.7(C)(15)(a)/(b) when equipment meets requirements

OR

## Calculations Method

Perform arc flash study to estimate incident energy (IE)

- Methods listed in NFPA 70E Annex D (IEEE 1584, etc.)

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# Required Label Information

Nominal system voltage

AND

Arc Flash boundary

AND at least 1 of the following:

a) Incident energy and working distance\*

OR

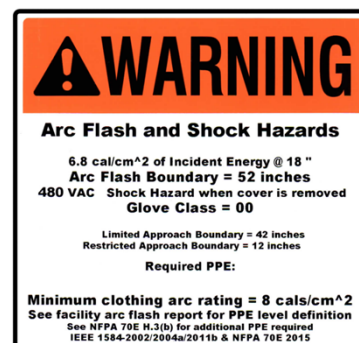
required PPE Category, based on tables\*

\* Either acceptable, but not both

b) Min. arc rating of clothing

c) Site Specific PPE Level

Method of calculating data on labels shall be documented



## Best Practice:

Separate LARGE Label with upstream device information "fed from..."

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## What Equipment Must be Labeled?

- Switchboards
- Panelboards
- Industrial Control Panels
- Meter Socket Enclosures
- Motor Control Centers
- and electrical equipment...

“likely to require examination, adjustment, servicing or maintenance while energized shall be field-marked with a label...”

### Field-marked label

- Documentation
- Installation
- Maintenance

...is the responsibility of equipment owner

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## More Guidelines in Determining Arc Flash Risk

- May use combination of the two methods within a facility, but not on individual equipment
- 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



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# How Do I Know the Severity?

Assessing Risk

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**Example Risk Assessment**

**TASK ASSIGNMENT:** Location: Hospital

**Troubleshoot non-operational branch circuit in an energized 480 volt, 3 phase panelboard.**

- Panelboard feeds equipment in ICU; critical not to interrupt power to life support devices
- Fed from molded-case circuit breaker
- Available fault current: 20 KA

3) **Shock Hazard** Present

☒ YES, Identify

☐ NO

**SHOCK**

|   |           |
|---|-----------|
| a) <b>Voltage</b> to which personnel will be exposed: | 480 V     |
| b) <b>Limited</b> Approach Boundary (LAB):            | 3'6" (1m) |
| c) <b>Restricted</b> Approach Boundary (RAB):         | 1' (.3m)  |

Add VR gloves and insulated tools to #6

4) **Arc Flash Hazard** Present (per Table 130.5(C))

☐ YES

☐ NO

**Arc Flash Hazard?**

- Look at *Task* and *Equipment Condition* and determine if there is a likelihood of an arc flash incident
- Is there a label affixed to the equipment per NFPA 70E?

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# Example Risk Assessment

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- Available fault current: 20 KA

4) **Arc Flash Hazard** Present (per Table 130.5(C))

☒ YES

- a) Does equipment contain a label per 130.5(H)?  
b) If no label, is equipment within parameters of PPE Category Tables?

☐ NO

☐ YES, Identify

☐ NO



Contact Engineering....

**ARC FLASH**

b) **Arc Flash** Boundary (AFB):

c) **PPE** Category (1-4):

*Detail PPE and Equipment at #6*

- Look up Equipment
- Check Notes

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# Example Risk Assessment

**TASK ASSIGNMENT:** Location: Hospital

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4) **Arc Flash Hazard** Present (per Table 130.5(C))

☒ YES

- a) Does equipment contain a label per 130.5(H)?  
b) If no label, is equipment within parameters of PPE Category Tables?

☐ NO

☒ YES, Identify

☐ NO



Contact Engineering....

**ARC FLASH**

b) **Arc Flash** Boundary (AFB): **36"**

c) **PPE** Category (1-4): **Cat 2**

*Detail PPE and Equipment at #6*

- Look up Equipment
- Check Notes

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# Example Risk Assessment

5) Details for **restricting access** to work area by unqualified persons:

|  |                  |
|--|------------------|
| a) <b>Method</b> (Barricades, Attendants, etc.)                      | <b>Barricade</b> |
| b) <b>Distance</b> from equipment for restrictions (> of LAB or AFB) | <b>3'6" (1m)</b> |

6) Details of **PPE and Equipment** Required:

|  |       |   |
|--|-------|---|
| Min. Arc Rating<br>for Equipment<br><br><b>8</b> cal/cm <sup>2</sup> | Head  | Hard hat (Class E), eye and ear protection, face shield & Balaclava |
|  | Body  | Long sleeve shirt, pants or coverall                                |
|  | Hands | Rubber gloves w/ leather protectors                                 |
|  | Feet  | Leather shoes   |
|  | Other | Insulated tools   |

7) Do you agree the above-described work can be done safely?

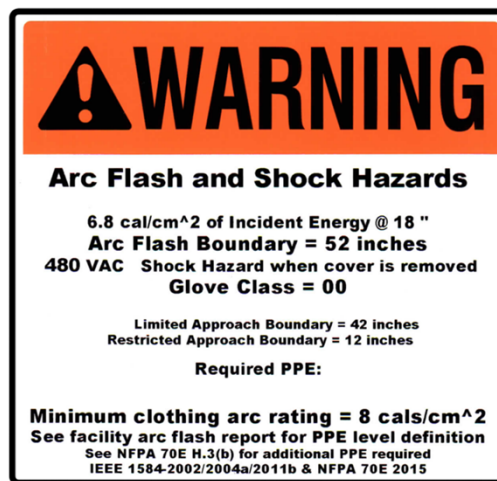
☒ YES

☐ NO Why Not?

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## Equipment with Label



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# How Do We Know if It Is Working?

Auditing as Quality Control

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## Training and Auditing Strongly Improve Compliance

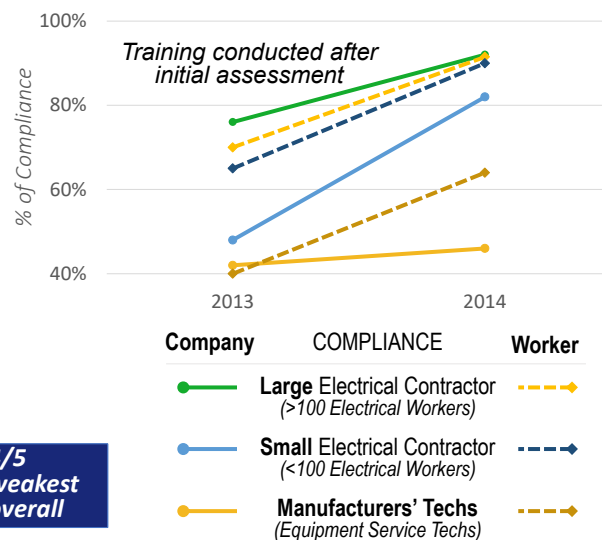
Study conducted in 2013 and 2014

- **Audit companies** for compliance to NFPA 70E-2012
- **Audit workers** for:
  - Understanding employer's safety program
  - Compliance to employer's directives

### Specific Assessment Criteria

1. Select pre-approved work plan (SOP)
2. Applicability of SOP based on work site, equipment and worker conditions
3. Using employer provided processes to develop work plan if no SOP exists
4. Recognizing difference between "energized or de-energized" conditions
5. Appropriate selection, inspection, use, maintenance and storage of PPE

**4/5  
weakest  
overall**



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IEEE, ESW2015-19, Hazard or Risk Analysis, Overcoming the Human Factor, by Robert S. LeRoy, CIESCP; Study Conducted at Chevron SJVBU, 2013-14

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## Training, Auditing and Reporting Effects



The Effects of Training, Goal Setting, and Knowledge of Results on Safe Behavior: A Component Analysis, Robert A. Reber and Jerry A. Wallin, The Academy of Management Journal, Vol. 27, No. 3 (Sep., 1984), pp. 544-560

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## Supervisory Safe Work Practice Inspection

### Annually inspect all qualified workers

Observations do the following:

- Document proficiency,
- Prove procedures work,
- Identify:
  - Procedures that don't work,
  - Changes that should be made,
  - Retraining needs.



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## Qualified Person Retraining

Retraining shall not exceed 3 years



### Retraining required:

- Tasks performed less than once per year
- Supervision or annual inspection indicates non-compliance with work practices
- New technology, new equipment or changes in procedures
- Rare or abnormal safe work practice requirements

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## Record Keeping

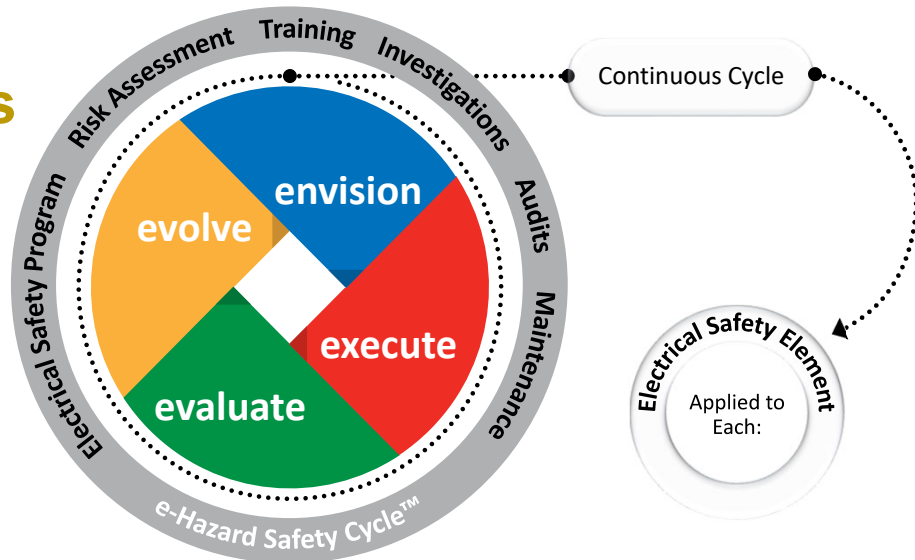
|   |  |
|---|--|
| Training required minimum every 3 years   | NFPA 70E <b>110.6(A)(3)</b>                                |
| Document skill proficiency  | NFPA 70E <b>110.6(A)(5)</b>                                |
| Dielectric test records of: <ul style="list-style-type: none"> <li>• HV live-line tools,</li> <li>• rubber gear,</li> <li>• insulated mobile equipment.</li> </ul>  | OSHA 1910.269(j)<br>OSHA 1910.137(c)<br>OSHA 1910.68(e)(3) |
| Some incident records required  | OSHA 300 Log   |
| Annual supervisory safe work practice inspections   | NFPA 70E <b>110.6(A)(1)(f)</b>                             |
| Audit documentation required for: <ul style="list-style-type: none"> <li>• Electrical safety program (at least every 3 yrs.),</li> <li>• Annual field work,</li> <li>• Lockout/tagout program.</li> </ul> | NFPA 70 E <b>110.5(M)</b>                                  |

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# Electrical Safety: A Continuous Cycle



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## Complete the Online Evaluation



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