

**OSC | 11**  
Ohio Safety Congress & Expo



**#431 NFPA 70E 2009 and possible future changes**

Jack Hirschmann, Jr.

Wednesday, March 30, 2011  
8:30 to 9:30 a.m.



**Electrical Safety**  
Understand & Comply – NFPA70E & CSA Z462



**Presenter**

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**Electrical Safety**  
Understand & Comply – NFPA70E & CSA Z462



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- **Introduction to the Electrical Safety Standards – NFPA 70E & CSA Z462**

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- **Introduction to NFPA 70E & CSA Z462**
  - Initial understanding of the NFPA 70E and CSA Z462 standards
  - The role the standards play in worker safety in the electrical industry
  - How to comply
- 4 Principles → 4 legs of the chair
- How to use the NFPA 70E Tables for hazard analysis and PPE selection

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**The most comprehensive standards to consult when developing an electrical safety program.**



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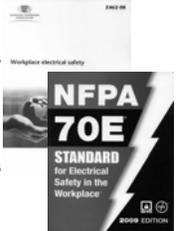
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**Who needs NFPA 70E or CSA Z462?**

Workers performing tasks on energized electrical conductors or circuit parts operating at or above 50 volts

Workers within the Arc Flash Protection Boundary or the Limited Approach Boundary of energized electrical conductors or circuit parts



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### Limits of Approach for an Electrical Hazard

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### Limits of Approach for an Electrical Hazard

The shock protection boundaries and the arc flash hazard boundary are independent of each other.

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**These arc flash and shock hazard boundaries are in place until you establish an electrically safe work condition.**

**NFPA 70E fundamental:**  
**4 Steps—you are at risk until you:**

1. De-energize
2. Lock out or Tag out
3. Test for voltage
4. Apply safety grounds

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**Tasks where you are at risk:**

- Taking voltage meter measurements
- Opening or closing disconnects
- Installing or Removing Breakers
- Removing panels or dead fronts
- Opening or Closing equipment doors



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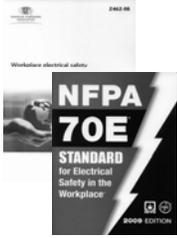
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**How does NFPA 70E or CSA Z-462 help you?**

- Protects you and your workers
- Preserve the bottom line of your company



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**What is an Arc Flash**

- Extremely High Heat Energy
- Explosive In Nature
- Typically Lasts Less Than 1 Second
- The heat exposure is over and done with before you know it happened



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**What is an Arc Flash Exposure**

- Hotter than the surface of the sun
- Can ignite and/or melt conventional work clothing
- Can cause burn injuries to unprotected skin
- Only takes an instant but the effects can last a life time

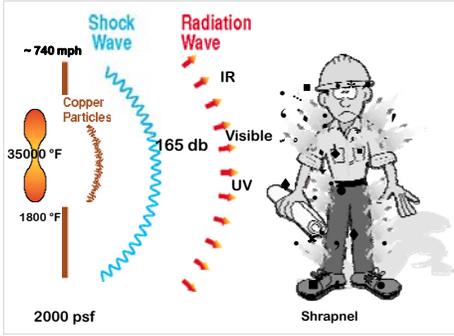


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~ 740 mph Shock Wave  
35000 °F Copper Particles  
1800 °F  
2000 psf  
Radiation Wave  
IR  
165 db  
Visible  
UV  
Shrapnel

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**Burn Depth Is A Measure Of Severity**

- 1<sup>st</sup> Degree: Skin Becomes Red, No Blister
- 2<sup>nd</sup> Degree Burn: Skin Blisters, Epidermis Must Regenerate ~100 Microns In Depth
- 3<sup>rd</sup> Degree Burn: Full Thickness Of Skin Destroyed, Skin Can Not Regenerate, Scar Tissue Forms 1,000 to 2,000 Microns In Depth
- 4<sup>th</sup> Degree: Muscle And Bone Are Damaged >2000 Microns



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**Electric Arc Flash**



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**The Four-Legged Chair**



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**Leg 1**

**QUALIFIED PERSON**

- “One who has 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.”



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**Leg 1**

**QUALIFIED PERSON**

- “Employees shall be regularly instructed in methods of first aid and emergency procedures.”
- “Training of employees in approved methods of resuscitation, including cardiopulmonary resuscitation, shall be certified by the employer annually.”



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**Leg 2**

**ENGINEERING CONTROLS**

- Reduce hazard levels with engineering controls
- Decrease clearing time
- Decrease available arc fault current



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**Leg 3**

**WORK PRACTICES**

- Develop a Safety Program
- Plan every job before a task begins



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**Leg 3**

**WORK PRACTICES**

**De-energize**

“Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is not feasible due to equipment design or operational limitations.”



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**Leg 3**

**WORK PRACTICES**

- Lockout
- Tagout



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**Leg 3**

**WORK PRACTICES**

- Work Permit

Energized electrical work shall be performed by written permit only.



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**NFPA 70E Annex J - Energized Electrical Work Permit**



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**Leg 4**  
**PPE PROGRAM**  
– PPE Your Last Line of Defense

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**Leg 4**  
**PPE PROGRAM**

**NFPA 70E fundamental:**  
**Arc Flash hazard analysis**

“An arc flash hazard analysis shall determine the Flash Protection Boundary and the personal protective equipment that people within the Arc Flash Protection Boundary shall use.”

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**Boundaries for Arc Flash Protection and Shock - Approach Limits**

Unqualified Personnel + PPE and Supervision  
Qualified + Competent + Incident Energy Calcs and PPE

Unqualified Personnel + PPE and Awareness and Qualified Escort  
Qualified + Competent for Job + Incident Energy Calcs and PPE

No Unqualified Personnel  
Qualified + Competent for Job + Calcs + PPE + Authorized Work Plan and No Ingress to Prohibited

No Unqualified Personnel  
Qualified + Competent for Job + Contact Work Justification + Specialized Training + Approved Risk Analysis + Approved Work Plan + PPE and Tools

Energized Exposed Electrical Equipment

Safe      Arc Flash Protection Boundary      Limited      Restricted      Prohibited

Table 130.2(C)  
Approach Boundaries to Energized Electrical Conductors on Circuit Parts for Shock Protection

	Limited	Restricted	Prohibited
480 V	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.
600 V	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.
1160 V	5 ft. 0 in.	2 ft. 2 in.	0 ft. 7 in.
13800 V	5 ft. 0 in.	2 ft. 2 in.	0 ft. 7 in.

Detailed Arc Flash and Shock Label

Note: HRC2 Arc Flash + Shock PPE for 480 V Energized Work Task as example

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**Leg 4**  
**PPE PROGRAM**

- Arc Flash hazard analysis Resources
- NFPA 70E Annex D equations, or
- IEEE Std 1584TM – 2002, or
- Software programs such as EasyPower™, ArcPro™, Heat Flux Calculator, SKM or ETAP.
- Tables Method

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**Hazard Analysis of Large Industrial Co.**  
33 sites – Estimated Annual Exposures

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**Percent of Total Exposures**

HRC Level	Percent of Total Exposures
0.4 > HRC 5 (.100 cal/cm²)	0.4
1.4 HRC 5 (40 - 100 cal/cm²)	1.4
2.4 HRC 4	2.4
HRC 3	8.5
HRC 2	13.4
HRC 1	35.1
HRC 0	38.7

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**Tables Method**  
First: Hazard Analysis with Table 130.7(C)(9)  
Next: PPE Selection with Table 130.7(C)(10)  
Six levels of Hazard/Risk Category

**Exposure level of task in cal/cm²**

HRC0	0 to 1.2
HRC1	1.2 to 4
HRC2	4 to 8
HRC2*	~8
HRC3	8 to 25
HRC4	25 to 40

**Tasks above 40 → Can't use Tables Method**

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**Hazard Analysis and PPE Selection—Tables Method**  
NFPA 70E Table 130.7(C)(9) - Hazard/Risk Category

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulated Glove	Insulated & Insulating Hand Tools
600V Class Switchgear (with power circuit breakers or fused switches)—Note 4			
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors opened or closed	4	N	N

HRC1 = Tasks up to 4 cal  
HRC2 = Tasks 4 to 8 cal  
HRC2\* = Tasks at 8 cal  
HRC3 = Tasks 8 to 25 cal  
HRC4 = Tasks 25 to 40 cal

Note 4: Maximum of 35 kA short circuit current, maximum of 0.5 sec. (30 cycles) fault clearing time

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**NFPA 70E Table 130.7(C)(10) – Protective Clothing & PPE**

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**Hazard/Risk Category 2\***

FR Clothing, Minimum Arc Rating of 8 (Note 1)  
Arc-rated long-sleeve shirt (Note 5)  
Arc-rated pants (Note 5)  
Arc-rated coverall (Note 6)  
Arc-rated face shield or arc flash suit hood (Note 10)  
Arc rated jacket, parka, or rainwear (AN)

Note 1. See 130.7(C)(11). Arc Rating expressed in cal/cm<sup>2</sup>  
Note 5. FR shirt & pants shall have a minimum arc rating of 8  
Note 6. Alternate is to use FR coveralls, min. arc rating of 8  
Note 10. Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face, head and neck except for the eye and nose areas.

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**NFPA 70E Table 130.7(C)(10) – Protective Clothing & PPE**

**Hazard/Risk Category 2\* (continued)**

**FR Protective Equipment**  
Hard hat  
Safety glasses or safety goggles (SR)  
Hearing protection (ear canal inserts)  
Leather gloves (Note 2)  
Leather work shoes

Note 2. If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

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**Tables Method**  
How is the Hazard/Risk Category Determined

- Both the hazard level and the risk of occurrence are considered
- Calculated incident energy of the arc flash event determine the hazard level
- Perceived low risk of arc flash occurrence reduces the Hazard/Risk Category
  - Low risk reduces HRC by 1 level
  - Very low risk reduces HRC by 2 levels
  - Extremely low risk reduces HRC by 3 levels

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**Hazard Analysis and PPE Selection—Tables Method**  
NFPA 70E Table 130.7(C)(9) - Hazard/Risk Category

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulated Glove	Insulated & Insulating Hand Tools
600V Class Motor Control Centers (MCCs)—Note 2 (except as indicated)			
CB or fused switch or starter operation with enclosure doors closed	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Insertion or removal of individual starter "buckets" from MCC—Note 3	4	Y	N

Level cal/cm<sup>2</sup>  
HRC0 = 0 to 1.2  
HRC1 = 1.2 to 4  
HRC2 = 4 to 8  
HRC2\* = -8  
HRC3 = 8 to 25  
HRC4 = 25 to 40

Note 2: Maximum of 65 kA short circuit current, maximum of 0.03 second (2 cycles) fault clearing time.  
Note 3: Maximum of 42 kA short circuit current, maximum of 0.33 second (20 cycles) fault clearing time.

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NFPA 70E Table 130.7(C)(9) - Hazard/Risk Category

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulated Glove	Insulated & Insulating Hand Tools
600V Class Switchgear (with power circuit breakers or fused switches) — Note 4			
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N

Level cal/cm<sup>2</sup>  
HRC0 = 0 to 1.2  
HRC1 = 1.2 to 4  
HRC2 = 4 to 8  
HRC2\* = -8  
HRC3 = 8 to 25  
HRC4 = 25 to 40

Note 4: Maximum of 35 kA short circuit current, maximum of 0.5 second (30 cycles) fault clearing time.

What's wrong with this column of changing HRC levels?

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All 3 tasks are on the same equipment with the same hazards level of 40 cal/cm<sup>2</sup>  
**HRC 0 = flammable cotton clothing**  
**HRC 2\* = FR clothing and PPE with an arc rating of 8 cal/cm<sup>2</sup> covering the full body**  
**HRC 4 = FR clothing and PPE with an arc rating of 40 cal/cm<sup>2</sup> covering the full body**

It is important to recognize the selected clothing and PPE arc rating has been reduced in the Table—and to make a conscious decision that this is appropriate for the actual task being performed.

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**The Right PPE Can Save Your Life**  
**NFPA 70E fundamental:**  
**PPE = or > Hazard Level**



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**Proprietary Fabrics**

- Inherently FR
- Strong & Durable
- No Special Washing
- Meet NFPA 70E



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**State of the Art Polycarbonate Arcshield™ Technology**

- High Impact Strength Resistance
- High Visible Light Transmission
- Antifog Inside
- Scratch Resistant Outside



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**Broadest Product Line**

- Dailywear
- Gloves
- Underwear



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**State of the art accessories**

- Arc Flash Cooling Vest



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**State of the art accessories**

- Hood Ventilation System

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Mr. Jack Hirschmann, President & CEO  
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**In summary, Remember The Four-Legged Chair.**

1. **QUALIFIED PERSON**
2. **ENGINEERING CONTROLS**
3. **WORK PRACTICES**
4. **HAZARD ANALYSIS & PPE**

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**Electrical Safety**  
Understand & Comply – NFPA70E & CSA Z462

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**NFPA 70E Fundamentals**

**De-Energize, Test for Voltage, Lockout/Tagout, Apply Safety Grounds**

**Hazard Analysis**

**Select PPE = or > Hazard Level**

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**Q & A**

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