OSC | 10
Ohio Safety Congress & Expo

Welcome

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Gone in a flash... Electrical safety-related work practices: Keys to compliance

142/143

Bob Nicholson, JDRM Engineering
Glenn McGinley, BWC-PERRP
Todd Jensen, OSHA

April 01, 2010 9:15 to 10:15 a.m. and 10:30 to 11:30 a.m.

Ohio

OSHA and NFPA 70E Electrical Safety Education

OSHA

Ohio PERRP

JDRM Engineering, Inc.

Ohio

Session Objectives

- Provide a basic understanding of the factors involved in an Arc Flash event
- Key OSHA standards related to electrical safety-related work practices and how they are enforced by OSHA and PERRP
- Key provisions from NFPA 70E used by OSHA to determine if a "feasible" method exists for electrical hazard control
- Elements of an electrical safety-related work practices program and requirements for "qualified" persons
- Jurisdictional authority of OSHA and PERRP to enforce electrical safety related work practices.

Employer Training Objectives

OSHA **29 CFR 1910.332**

- Specific Electrical Task and PPE Training is a requirement of each employer, to be supplied to their employees at their facility. Failure to perform training activities constitute a violation of the intent of the OSHA's training requirements
- Classroom, computer based training by itself is not sufficient to meet the intent of the OSHA's training requirements

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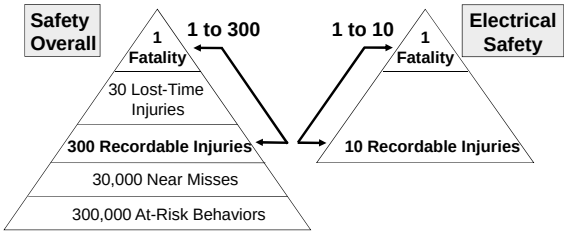
Why Electrical Safety?



Slide courtesy of Cooper Bussmann

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Westex Arc Flash Videos

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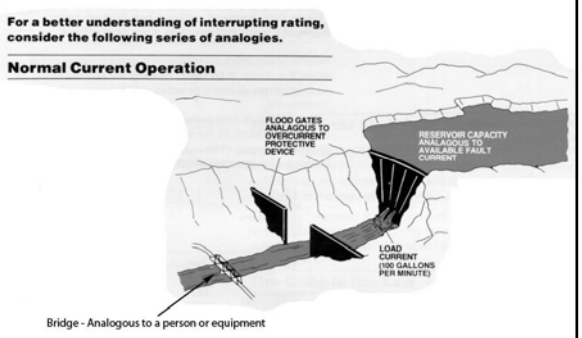
Fault Current and Protective Device Clearing Time



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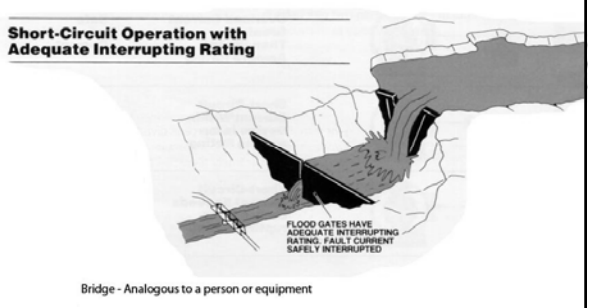
Fault Current and Protective Device Clearing Time



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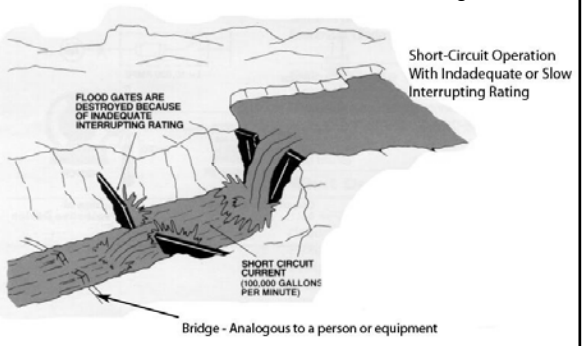
Fault Current and Protective Device Clearing Time



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Simulation-Fault Current and Protective Device Clearing Time

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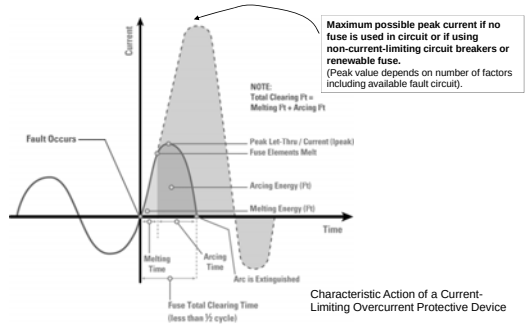
Current Limitation



Characteristic Action of a Current-Limiting Overcurrent Protective Device

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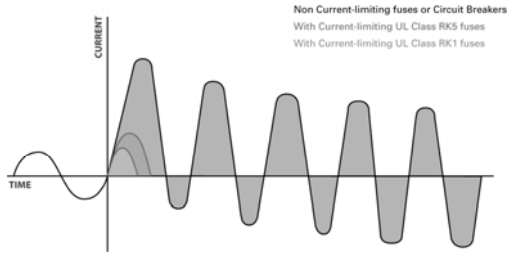
Current Limitation



Current limiting overcurrent protective devices reduce the total destructive heat energy (I^2t) to the circuit and it's components to a small fraction of the energy available in the system. This is represented by the colored, shaded areas above.

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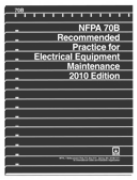
Equipment Maintenance

Periodically, de-energize equipment and perform maintenance as recommended in NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance."



- Clean interior of equipment enclosures
- Check bolted connections for proper torque
- Perform any maintenance per manufacturer's instructions
- Maintain logs of maintenance and inspections performed

Refer to NFPA 70B Annex I – Maintenance Intervals

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Electrical Hazards

- **Electric Shock** - trauma caused by the passage of electric current through the body.

Photo courtesy of Littelfuse

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Electrical Shock

- An electrical shock is received when current passes through the body
- Severity of the shock depends on:
  - Path of current through the body
  - Amount of current flowing through the body
  - Length of time the body is in the circuit
- *LOW VOLTAGE DOES NOT IMPLY LOW HAZARD!*

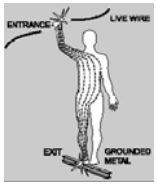

Image courtesy of OSHA

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Effects of Electricity on the body

Milliampere	Affect on Person
0.5 – 5 mA	Tingling sensations
3+ mA	Shock
10-15 mA	Muscle contractions and pain threshold
20+ mA	Respiratory paralysis
75-100+ mA	Ventricular fibrillation (usually fatal)
2+ Amps	Heart Paralysis
5+ Amps	Tissue and organs start to burn

NOTE: Average electrical circuit breaker trips at 15-20 AMPS

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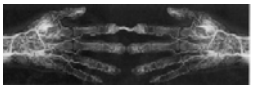
Electric Shock



- Over 30,000 non-fatal electrical shock accidents occur each year
- Over 600 people die from electrocution each year
- Electrocution remains the fourth (4th) highest cause of industrial fatalities
- Most injuries and deaths could be avoided

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Simulation-Shock Incidents Lesson #2

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Electrical Hazards

- **Arc-Flash** – an unexpected sudden release of intense heat and light energy produced by electricity traveling through air, usually caused by accidental contact between live conductors.
- **Arc-Blast** - a pressure wave created by heating, melting, vaporization, and expansion of conducting material and surrounding air during an Arc-Flash.

Photos courtesy of Littelfuse

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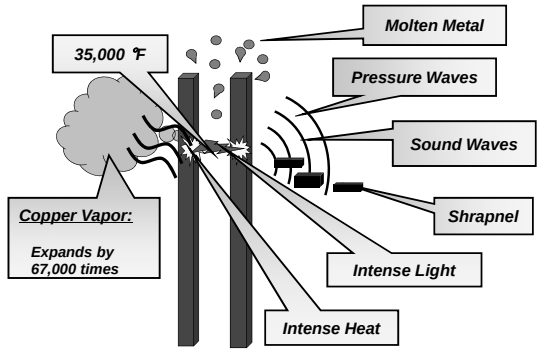
Electrical Arc



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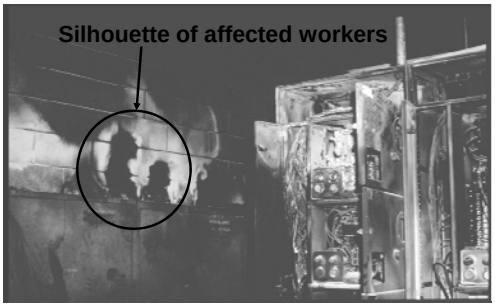
Impact on Workers & Business



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Arc-Flash Incident on Camera

Video Clip 4b

http://www.metacafe.com/watch/1555440/arc_flash_while_racking_a_breaker/

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Arc Flash & Arc Blast Potential Effects

- Heat – burns & ignition of material
  - Arc temperature of 35,000°F
  - Molten metal, copper vapor, heated air
- Second degree burn threshold:
  - 80°C / 175°F (0.1 sec), 2nd degree burn
- Third degree burn threshold:
  - 96°C / 205°F (0.1 sec), 3rd degree burn
- Intense light
  - Eye damage, cataracts

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Arc Flash & Arc Blast Potential Effects

- Pressures from expansion of metals & air
- Eardrum rupture threshold:
  - 720 lbs/ft^2
- Lung damage threshold:
  - 1728 - 2160 lbs/ft^2
- Shrapnel
- Thrown across the room

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Temperature Data Related to Burns

- Curable burn temperature (0.1 sec) 176° F
- Cell death temperature (0.1 sec) 205° F
- Temperature of burning clothing 1,400° F
- Clothing ignition temperature 700-1,400° F
- Temperature of metal droplets 1,800° F

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Incident Energy

- "The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the units used to measure incident energy is calories per centimeter squared (cal/cm^2)."

(NFPA 70E-2009, Article 100)

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Relative Incident Energy

- A butane lighter held 1 cm (3/8") below your finger
- The blue portion of the flame should be just touching
- Duration of 1 second
- Will give 1 square cm of your finger 1 cal/cm^2
- 1.2 cal/cm^2 can cause a blister, a second degree burn

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Personal Protective Equipment

NFPA 70E-2009
Table 130.7(C)(11) Protective Clothing Characteristics

Hazard Risk Category	Clothing Description	Rating Cal/cm^2
0	Non-melting flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight of at least of 4.5 oz/yd^2 (1)	N/A
1	FR shirt & FR pants or coverall (1)	4
2	Cotton underwear plus FR shirt & FR pants (1 or 2)	8
3	Cotton underwear plus FR shirt & FR pants plus FR coverall or cotton underwear plus two FR coveralls (2 or 3)	25
4	Cotton underwear plus FR shirt & FR pants plus double layer switching coat & pants (3 or more)	40

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Table 130.7(C)(11) Note

- NFPA 70E-2009 Handbook **(emphasis added):**

"**HRC 0 is not FR clothing**. The use of HRC 0 is only for those tasks listed in Table 130.7(C)(9) that permit HRC 0. If Table 130.7(C)(9) is not used or a task is not listed in the table, an incident energy analysis must be used. **Section 130.7(C)(5) requires FR clothing to be used for all incident energy levels above 1.2 cal/cm2**."

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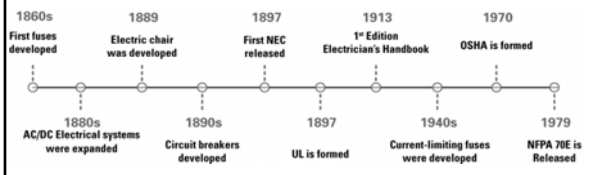
Electrical Safety History (1860-1979)



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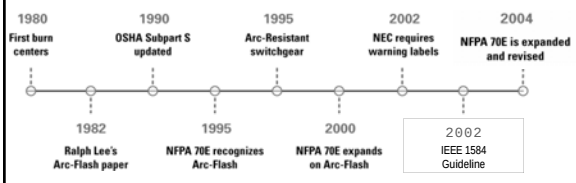
Electrical Safety History (1980-2004)



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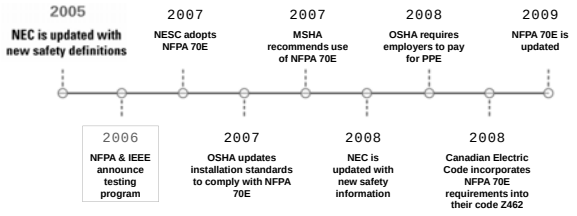
Electrical Safety History (2005-2009)



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Introduction to OSHA & PERRP

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What is OSHA? What is PERRP?

- **O**ccupational **S**afety and **H**ealth **A**dministration
- **P**ublic **E**mployment **R**isk **R**eduction **P**rogram
- In Ohio, both agencies are responsible for worker safety and health protection.
- OSHA covers private sector employers
- PERRP covers public sector employers.
- Both agencies enforce regulations from Title 29 in the Code of Federal Regulations

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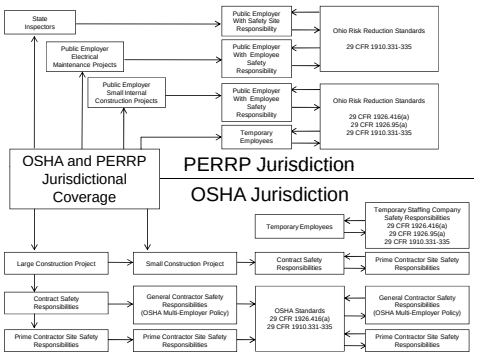
Jurisdictional Flow Chart



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Occupational Safety & Health Act of 1970

OSHA "General Duty Clause"

5. Duties
   a. Each Employer
      1) 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

NOTE: Ohio Revised Code (ORC) 4167.04(a)(1) is the equivalent standard applicable to Ohio public employers.

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OSHA "Hierarchy of Controls"

1. **Engineering Controls –** Seek to eliminate the hazards at the source.
2. **Safety/Process Controls –** Can not eliminate hazard…reduce the hazard and/or worker exposure to hazardous conditions**.**
3. **PPE Controls –** Devices and clothing worn by workers to safeguard themselves against the hazards

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Employee PPE Requirements

29 CFR 1910.335(a)(1)(i)

Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

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Work on or near exposed energized parts

29 CFR 1910.333(c)(2)

Only qualified persons may work on electric circuit parts or equipment that have not been deenergized under the procedures of paragraph (b) of this section. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.

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Are you OSHA Qualified?

29 CFR 1910.399 Definition

Qualified person. One who has received training in and has demonstrated skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved.

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Qualified Persons

- Qualified persons (i.e., those permitted to work on or near exposed energized parts) must be trained in and familiar with the following:
  - The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.
  - The skills and techniques necessary to determine the nominal voltage of exposed live parts, and
  - The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.
- It is important to recognize that “qualified” employees are not necessarily capable of performing all electrical tasks.

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“Un” Qualified Persons

- A *Qualified person* must receive training in and must **<u>demonstrate</u>** skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved.

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“Un” Qualified Persons

- Whether an employee is considered to be a "qualified person" will depend upon various circumstances in the workplace.
- It is possible and, in fact, likely for an individual to be considered "qualified" with regard to certain equipment in the workplace, but "unqualified" as to other equipment.

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Does this equipment require different training?



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Work it Hot or Not?

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Review of OSHA Requirements

- OSHA requires employers to protect workers from recognized hazards.(Shock and Arc Flash)
- **OSHA says Deenergize and LO/TO <u>and</u> assess for Hazards and use PPE!**
- When deenergization isn't feasible…
- 29 CFR 1910.331-335 requires employers to train employees to recognize electrical hazards and use safe work practices.

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High Voltage Arc

Image from IEEE Electrical Safety Workshop, Jim Bowen

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Working on LIVE parts

29 CFR 1910.333(a)(1)

Deenergized parts.

Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

Live parts that operate at less than 50 volts to ground need not be deenergized <u>if</u> there will be no increased exposure to electrical burns or to explosion due to electric arcs.

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OSHA Lockout / Tagout Requirements

29 CFR 1910.333(b)(2)

Lockout and tagging. While any employee is exposed to contact with parts of fixed electric equipment or circuits which have been deenergized, the circuits energizing the parts shall be locked out or tagged or both in accordance with the requirements of this paragraph…

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OSHA Lockout / Tagout Requirements

29 CFR 1910.333(b)(2)(iv)(B)
A qualified person shall use test equipment to test the circuit elements and electrical parts of equipment to which employees will be exposed and shall verify that the circuit elements and equipment parts are deenergized.

Note: When performing Lockout/Tagout procedures, qualified workers must use properly rated Shock and Arc-Flash PPE and test equipment to verify the circuit is deenergized.

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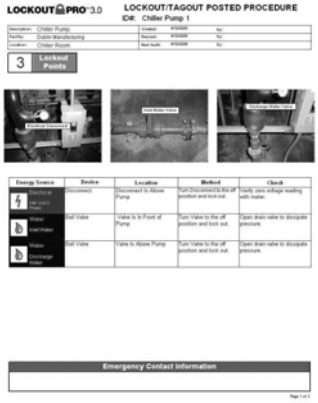
Lockout / Tagout Examples


LOCKOUTPRO 3.0 LOCKOUT/TAGOUT POSTED PROCEDURE
ID#: Chiller Pump 1

3 Lockout Points

Energy Source	Device	Location	Method	Check
Electrical	Disconnect	Disconnect is Above Pump	Turn Disconnect to the off position and lock out.	Verify zero voltage reading with meter.
Water	Ball Valve	Valve is In Front of Pump	Turn Valve to the off position and lock out.	Open drain valve to dissipate pressure.
Water	Ball Valve	Valve is Above Pump	Turn Valve to the off position and lock out.	Open drain valve to dissipate pressure.

Emergency Contact Information

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Lockout / Tagout Examples


LOCKOUTPRO 3.0 LOCKOUT/TAGOUT POSTED PROCEDURE
ID#: Chiller Pump 1

Notes

LOCKOUT APPLICATION STEPS

#	Step	Instruction	Additional Info
1	Notify Employees	Notify all affected employees that the machine or equipment will be shutdown and locked out.	
2	Review Procedure	Ensure that each authorized employee understands the type and magnitude of the energy present, the associated hazards and the proper methods of control.	
3	Shutdown Equipment	If the machine or equipment is operating, shut it down by the normal stopping procedure.	
4	Isolate Energy	De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).	
5	Lockout Controls	Lockout the energy isolating device(s) as indicated on the front of this procedure.	
6	Dissipate Energy	Dissipate any stored or residual energy as indicated on the front of this procedure.	
7	Verify Isolation	Verify that the energy source has been isolated as indicated on the front of this procedure.	

LOCKOUT RELEASE STEPS

#	Step	Instruction	Additional Info
1	Inspect Equipment	Check the equipment to ensure that the components are operationally intact.	
2	Check Area	Check the immediate area to ensure that all employees have been safely positioned, and that any nonessential items have been removed.	
3	Check Neutral	Verify that operating controls are in neutral.	
4	Re-Energize	Remove the lockout device(s) and activate the energy isolating device(s) to re-energize the equipment.	
5	Notify Employees	Notify affected employees that the servicing or maintenance is completed and the equipment is ready for use.	
6	Startup Equipment	Startup equipment and monitor for several operating cycles to ensure it is functioning properly.	

Procedure Change Notification
Contact your supervisor if you have any questions or concerns about the accuracy or effectiveness of this procedure.

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De-Energizing Equipment
Lockout/Tagout
Lesson #8

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OSHA Energized Parts

29 CFR 1910.333(2)
Energized parts

If exposed live parts are not deenergized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved.

Such work practices shall protect employees against contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object….

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Examples of Safety Related Work Practices

- Use of appropriate Personal Protective Equipment (PPE)
- Use of proper tools and test equipment
- Following Safe Work Procedures
- Worker training
- Worker certification
- Identify, assess, eliminate, or minimize hazards

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OSHA Safe Work Practice

29 CFR 1910.334(b)(2)

"Reclosing circuits after protective device operation."
After a circuit is deenergized by a circuit protective device, the circuit may not be manually reenergized until it has been determined that the equipment and circuit can be safely energized. The repetitive **manual reclosing of circuit breakers** or reenergizing circuits through **replaced fuses** is prohibited.

Note:
When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was **caused by an overload** rather than a fault condition, **no examination** of the circuit or connected equipment **is needed** before the circuit is reenergized.

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Basic's of Safety Related Work Practices

- **"Assess"** all Hazards
- **"Mitigate"** all Hazards
- **"Identify"** Employee's Qualified and Unqualified
- **"Provide"** Training, PPE, Safety Policies, Auditing
- **"Document"** Safety Programs

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NFPA 70 National Electrical Code (NEC) Safety Requirements

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NFPA 70-2008 (NEC) Article 110.16

Requirements for Electrical Installations (emphasis added)

110.16 Flash Protection.

Electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, 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.

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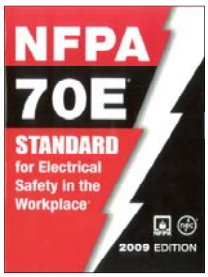
Introduction to NFPA 70E and IEEE 1584



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Introduction to NFPA 70E

NFPA 70E, *Standard for Electrical Safety in the Workplace*:

- The de facto "How to" standard to meet OSHA regulations.
- The industry preferred consensus standard to assess electrical hazard risks and implement safe work practices.
- Establishes Shock and Arc-Flash Protection Boundaries
- Determines Hazard Risk Categories and required Personal Protective Equipment
- Complies with OSHA and all state occupational safety standards
- Host Employer Responsibilities

NFPA is a registered trademark of the National Fire Protection Association (NFPA), Quincy, MA.

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NFPA 70E Terms and Definitions

- **Incident Energy** - amount of (heat) energy impressed on a surface at a certain distance from an Arc-Flash. Typically measured in cal/cm² at 18 in. away from the arc.
- **Hazard Risk Category** – a risk category defined by NFPA 70E that depends on the amount of incident energy possible at a certain working distance
- **Limited, Restricted, and Prohibited** protection boundaries - shock protection boundaries to protect un-qualified and qualified workers
- **Flash Protection Boundary** – distance from the Arc-Flash a person can receive a second degree burn to unprotected skin.
- **Personal Protective Equipment (PPE)** – equipment worn or used to protect workers.

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NFPA 70E Article 130.1

Article 130.1 Justification for Work.

(A) General. Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee works within the Limited Approach Boundary of those conductors or parts.

Exceptions:

(1) Greater Hazard. Energized work shall be permitted where the employer can demonstrate that deenergizing introduces additional or increased hazards.

(2) Infeasibility. Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a deenergized state due to equipment design or operational limitations.

(3) Less than 50 Volts. Energized electrical conductors and circuit parts that operate at less than 50 volts to ground shall not be required to be deenergized …

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Electrical Hazard Analysis

Before work is performed on energized equipment operating at 50 volts or more, **NFPA 70E Article 110.8(B)(1)** requires the employer to perform an Electrical Hazard Analysis.

- An Electrical Hazard Analysis consists of:
  - Shock Hazard Analysis
  - Flash Hazard Analysis
- An Electrical Hazard Analysis may also include:
  - Short circuit and coordination study
  - Analysis of equipment deficiencies
  - Review of Electrical Safety Program policies and operating procedures

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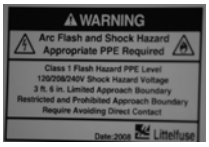
Equipment Labeling

New Article 130.3(C)

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



Example of minimum label requirements

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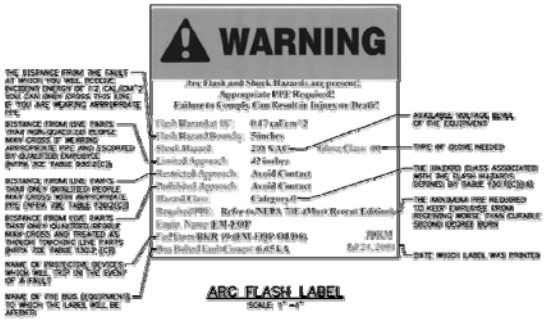
Detailed Arc Flash Equipment Label



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Over HRC 4 Danger Label

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Electrical Work Permits

NFPA 70E Article 130.1(B)(1) states:

"When working on energized electrical conductors or circuit parts that 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."

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Approach Boundaries

What about the Flash Protection Boundary?

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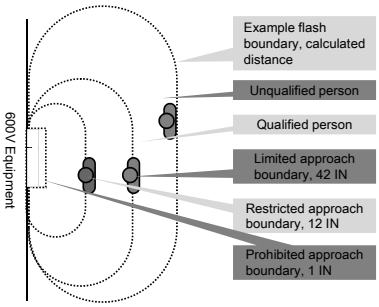
NFPA 70E Approach Boundaries



Approach boundaries to live parts NFPA 70E, Table 130.2(C)

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Simulation-Approach Boundaries Lesson #5

Simulation-Hazard Risk Categories Lesson #6

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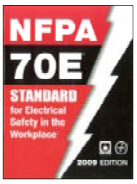
Flash Hazard Analysis Methods

NFPA 70E describes two methods to determine Hazard Risk Categories, Flash Protection Boundaries and required PPE :

1. NFPA 70E and IEEE calculations

   or

2. NFPA 70E Table 130.7(C)(9)



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IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations

- IEEE 1584 provides formulae to calculate possible Incident Energy and Flash Protection Boundary (FPB) based on:
  - System Voltage
  - Available fault current
  - Clearing time of overcurrent protective device, or type of overcurrent protective device (UL Class L and RK1 current limiting fuses, etc.)
  - Arc gap

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NFPA 70E Table Method

NFPA 70E-2009 Table 130.7(C)(9) Method

1. Determine task to be performed
2. Consult Table 130.7(C)(9) Read & Apply Notes
3. Look up voltage and equipment class
4. Find task in Table
5. **Read the and apply the table notes**
6. Determine Hazard Risk Category
7. Note if voltage rated tools and gloves are required
8. **Check and verify Notes**
9. Use appropriate PPE for Hazard Risk Category
10. Can be used during data gathering phase of Arc-Flash Hazard Assessment

NFPA 70E-2009 Table 130(C)(9) Notes

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 ($^1/_2$ 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.

NFPA 70E-2009 Table 130.7(C)(10)*

* Derived from NFPA 70E – 2009 edition. For details, please contact the National Fire Protection Association, Quincy, MA

HRC	Protective Clothing, Rating	Protective Clothing, FR Clothing	FR Protective Equipment
0	Non-melting (according to ASTM F 1506-00) or Untreated Natural Fiber	Shirt (long sleeve) Pants (long)	Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
1	Minimum Arc Rating of 4	Arc-rated long-sleeve shirt and arc-rated pants (Note 3) Alternate: Arc-rated coveralls (Note 4) Arc-rated face shield or flash suit hood (Note 7) Arc-rated jacket, parka or rainwear (AN)	Hard Hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes (AN)
2	Minimum Arc Rating of 8	Arc-rated long-sleeve shirt and Arc-rated pants (Note 5) Alternate: arc-rated coveralls (Note 6) Arc-rated face shield or flash suit hood (Note 7) Arc rated jacket, parka or rainwear (AN)	Hard Hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
2*	Minimum Arc Rating of 8	Arc-rated long-sleeve shirt and arc-rated pants (Note 5) Alternate: arc-rated coverall (Note 6) Arc-rated face shield or a flash suit hood (Note 10) Arc-rated jacket, parka or rainwear (AN)	Hard Hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
3	Minimum Arc Rating of 25	Arc-rated long-sleeve shirt (AR) (Note 8) Arc-rated pants (AR) (Note 8) Arc-rated coverall (AR) (Note 8) Arc-rated flash suit jacket (AR) (Note 8) Arc-rated flash suit pants (AR) (Note 8) Arc-rated flash suit hood (Note 8) Arc-rated jacket, parka or rainwear (AN)	Hard Hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes
4	Minimum Arc Rating of 40	Arc-rated long-sleeve shirt (AR) (Note 9) Arc-rated pants (AR) (Note 9) Arc-rated coverall (AR) (Note 9) Arc-rated flash suit jacket (AR) (Note 9) Arc-rated flash suit pants (AR) (Note 9) Arc-rated flash suit hood (Note 9) Arc-rated jacket, parka or rainwear (AN)	Hard Hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes

Compliance Summary

Conduct an Electrical Hazard Analysis

Calculate Incident Energy
Establish Hazard Risk Category
Determine Shock Protection Boundaries
Determine Flash Protection Boundary

Personnel Protective Equipment (PPE)
Identify Who is Qualified
Use Energized Work Permits

Images courtesy of Salisbury, Skokie, IL

Electrical measurement safety

Avoiding hidden hazards

Information courtesy of Fluke Corporation

OSHA Test Equipment Requirements

29 CFR 1910.334(c) Test Instruments and equipment (paraphrased)

(1) Only qualified persons may perform testing work on electric circuits or equipment.

(2) Test instruments and equipment must be visually inspected for external defects and damaged items must be removed from service.

(3) Test instruments and equipment and their accessories must be rated for the circuits and equipment to which they will be connected and designed for the environment.

Use Properly Rated Voltage Testers

Information courtesy of Fluke Corporation

Overvoltage Category	Examples
CAT IV	• Refers to the "origin of installation", i.e. where low-voltage connection is made to utility power. • Electricity meters, primary overcurrent protection equipment. • Outside the building and service entrance, service drop from the pole to building, run between the meter and panel. • Overhead line to detached building, underground line to well pump.
CAT III	• Equipment in fixed installations, such as switchgear and three phase motors. • Bus and feeder in industrial plants. • Feeders and short branch circuits, distribution panel devices. • Lighting systems in larger buildings. • Appliance outlets with short connections to service entrance.

CAT II	• Appliance, portable tools, and other household and similar loads.
	• Receptacle outlets and long branch circuits.
	  • Outlets at more than 10 meters (30 feet) from CAT III source.
	  • Outlets at more that 20 meters (60 feet) from CAT IV source.

CAT I	• Protected electronic equipment. • Equipment connected to source circuits in which measures are taken to limit transient voltages to an appropriately low level. • Any high-voltage, low-energy source derived from a high-winding resistance transformer, such as the high-voltage section of a copier.

Note: For most industrial work at 600V or less, use CAT III or CAT IV compliant meters.

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Look for CAT III or CAT IV markings

CAT III-1000 V
CAT IV -600V

CAT IV-600 V
CAT III-1000 V

CAT III-600 V

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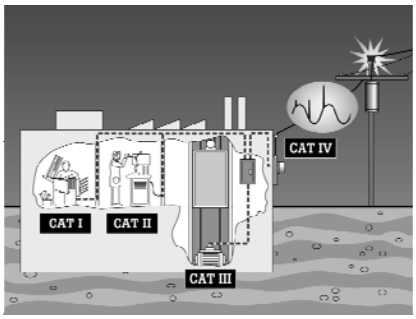
Category locations



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Personnel Protective Equipment

Images courtesy of Salisbury

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Electrical Safety PPE

NFPA 70E-2009
130.7(C)(1)

When an employee is working within the Arc Flash Protection Boundary he or she shall wear protective clothing and other personal protective equipment in accordance with 130.3. All parts of the body inside the Arc Flash Protection Boundary shall be protected.

Photos courtesy of Salisbury

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Hazard Risk Category 0

From IEEE IAS Electrical Safety Workshop 2005

100% cotton Long-sleeve Shirt, Long Pants,
Safety Glasses, Hearing Protection,
Leather and Insulated Gloves (as needed)

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Hazard Risk Category 1

From IEEE IAS Electrical Safety Workshop 2005

4+ Calorie Long Sleeve Shirt and Long pants, FACESHIELD, Hardhat, Safety Glasses, Hearing Protection, VR gloves as needed, Leather Gloves and Boots (AN)

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Hazard Risk Category 2

Double layered switching hood or Balaclava for 2*

From IEEE IAS Electrical Safety Workshop 2005

FR Shirt and Pants or Coverall (8+), Face shield, Safety Glasses, Hardhat, Insulated and Leather Gloves, Leather Shoes, Ear Plugs

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Hazard Risk Category 3

From IEEE IAS Electrical Safety Workshop 2005

25+ Calorie Flash suit (over long sleeve shirt and long pants), Voltage Rated Gloves/Leather Protectors, Leather Boots, Hearing Protection

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Hazard Risk Category 4

From IEEE IAS Electrical Safety Workshop 2005

40 cal. FR Suit (with hood over FR coveralls or FR shirt and pants), Leather Gloves, Insulated Gloves, Leather Boots, Ear Plugs

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Choose the Correct Glove

- Choose the correct class of glove for the task.
- Choose the glove by voltage.
- ASTM F1506, 29 CFR 1910.137(b)(2)(viii) and 70E-2009 Table 130.7(C)(6)(c) require gloves to be tested every 6 months.
- Alternating glove color program.

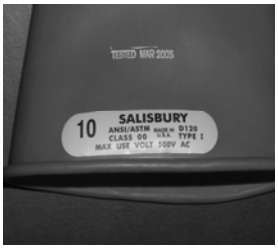

Photo courtesy of Salisbury

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ASTM Labeling Chart

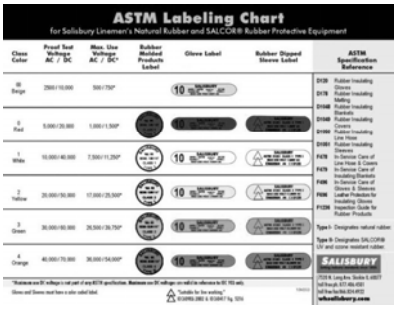

Image courtesy of Salisbury

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PPE Testing

- All electrically protective equipment must be tested every six months to be in accordance with 29 CFR 1910.137.
- In addition, gloves must be visually inspected to check for tears, rips and punctures, Ozone cutting, embedded foreign objects, swelling and softening
- Daily Inspection periodic proof testing ASTM 496 & 29 CFR 1910.137

Photo courtesy of Salisbury

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Insulated Tools

- Insulated tools that meet ASTM F1505 and 29 CFR 1910.335(a)(2)(i).
- Tools rated at 1000V must be used when working with energized equipment.
- V-rated tools.

Photo courtesy of Salisbury

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Simulation-PPE and Tools Lesson #7

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Summary

Safe Work Practice Checklist

1. Have you deenergized the equipment, LO/TO and used proper PPE to verify that it is deenergized?
2. Are you "qualified" and properly trained for the task?
3. Are you familiar with the equipment and understand the hazards involved?
4. Have you justified why the equipment cannot be deenergized while working on it?
5. Have you identified the safe work practices you will use to work on energized equipment?
6. Do you know the Voltage, Shock, and Flash Protection boundaries?
7. Do you know the possible Arc-Flash incident energy and Hazard Risk Category?

Safe Work Practice Checklist

(continued)

8. Did you inspect your PPE before using it?
9. Have you put barriers up to prevent unqualified workers from entering the area?
10. Is there adequate lighting to do the task?
11. Have you had a job briefing and does someone know you are working on energized equipment?
12. Do you have a signed Energized Work Permit by your manager?
13. Has your written Electrical Safety Policy been updated to conform with OSHA regulations and NFPA 70E?

If you can answer "Yes" to <u>all</u> of the questions on this checklist you are on your way to providing a safe workplace!

Safety Flow Chart Review

Thank you for attending!

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Ohio PERRP

OSHA

Information courtesy of :

Fluke Corporation

Littelfuse Power-Guard Services

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THANK YOU