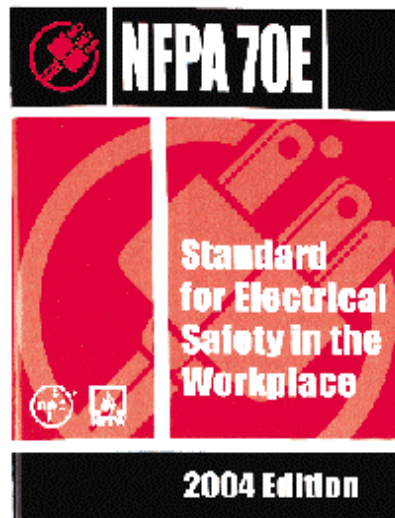


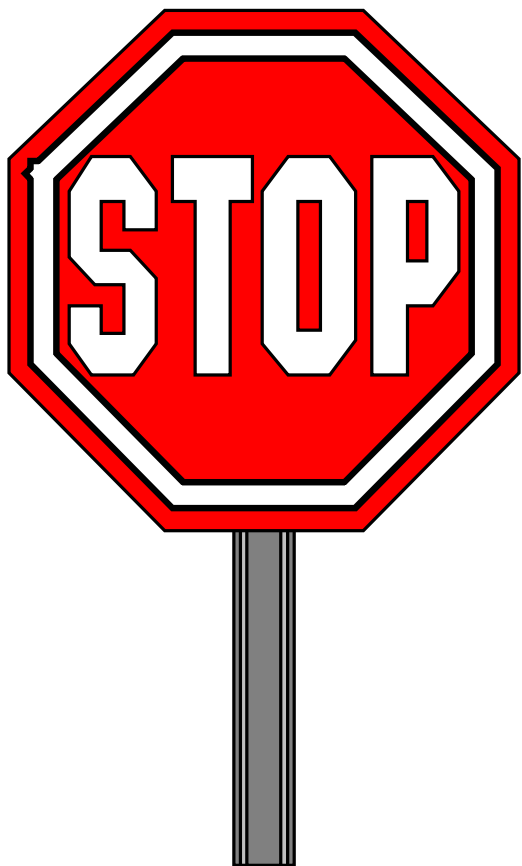


# Welcome to Electrical Safety Presentation



Presentation Prepared by Wm Bruce Bowman, P.E., Vice President of Fox Systems, Inc. of Calhoun, Georgia  
[bbowman@foxsystemsinc.com](mailto:bbowman@foxsystemsinc.com)

# What is the best way to prevent the hazards of electricity?

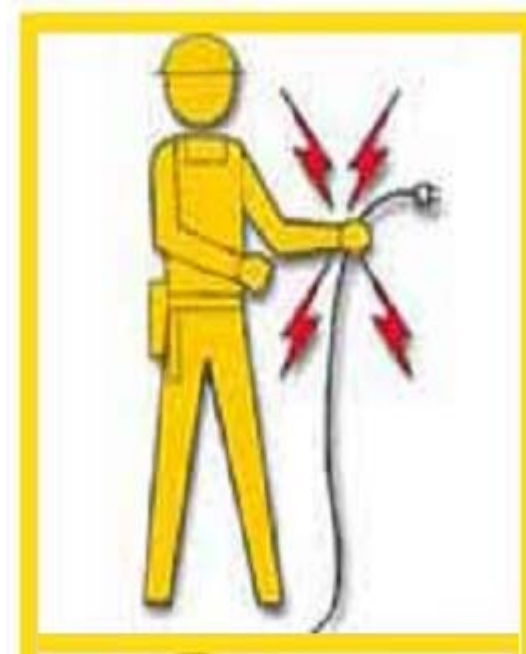


- **S**top
    - Before Action
  - **T**hink
    - Risks/Hazards
  - **O**ptions
    - LOTO
  - **P**rotection
    - Proper PPE
- 
- *Avoiding energized circuits is the Safest Way!*

# Electrical Safety

## Why Electrical Safety Practices and Procedures?

- 1) An estimated 30,000 non-fatal electrical shock accidents occur each year
- 2) Over 600 people die from electrocution each year
- 3) Electrocution remains the fourth (4th) highest cause of industrial fatalities
- 4) Approximately 3000 reported flash burn incidents reported annually along with approximately 350 deaths



# Electrical Safety

## *NFPA 70E – Standard for Electrical Safety in the Workplace*

- Formally “*Standard for Electrical Safety Requirements for Employee Workplaces*”
- Begin 1976 by NFPA to assist OSHA



# Electrical Hazards

- Shock



- Arc Flash  
& Arc Blast  
• Fire Ignition



# The Effects of Shock

- Immediate
  - Muscle contraction
  - Vital organs (Heart, Lungs, etc.)
  - Tingling
  - Pain
  - Breathing
  - Disorientation
  - Dizziness
- Long term
  - Memory Loss
  - Nervous disorders
  - Chemical imbalances
  - Damage to vital organs
  - Sometimes Fatal



# Effects of Current on the Body



Electrical Safety in the Workplace Ray A Jones, PE © 2001

## • *Men*

- Perception Threshold
  - 0.001 Amps (1 mA)
- Painful Shock
  - 0.009 Amps (9 mA)
- Cannot Leg-Go Level
  - 0.010 Amps (10 mA)
- Ventricular Fibrillation
  - 0.100 Amps (100 mA) 3 Seconds
  - 0.200 Amps (200 mA) 1 Second
- Heart Failure
  - 0.5 Amps (500 mA)
- Organ Burn and Cell Breakdown
  - 1.5 Amps (1500 mA)

## • *Women*

- Perception Threshold
  - 0.0007 Amps (0.7 mA)
- Painful Shock
  - 0.0012 Amps (1.2 mA)
- Cannot Leg-Go Level
  - 0.010 Amps (10 mA)
- Ventricular Fibrillation
  - 0.100 Amps (100 mA) 3 Seconds
  - 0.200 Amps (200 mA) 1 Second
- Heart Failure
  - 0.5 Amps
- Organ Burn and Cell Breakdown
  - 1.5 Amps

# Resistance and the body

- The body has a natural defense system (Skin)
- Why 50 volts?
- How can you raise body resistance?
- The key to survival is decrease our exposure.
- Ohm's Law for Electric current (amps), voltage and Body Resistance
- The typical body has a contact resistance of 500 ohms at the point of contact with the electrical source.
- The body has an internal resistance of approximately 100 ohms.
- There is another point of contact to ground of maybe 5000 ohms.
  - $120\text{v} / (500\Omega + 100\Omega + 5000\Omega) = 21\text{mA}$
  - $50\text{v} / (500\Omega + 100\Omega + 5000\Omega) = 8.9 \text{ mA}$
- It is around 10 mA that the “cannot let go” level is reached. Once lock up occurs, exposure time is increased and the possibility of electrocution may occur.

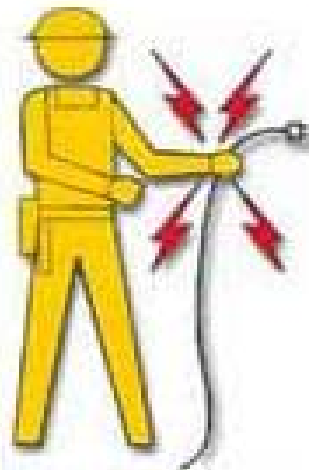
# Two Types of Burns from Shock

- Surface Burns
  - Caused by entrance and exit of electrical currents through the body
  - Can be caused by a very small amount of current
  - 1st degree to 3rd degree
- Internal Tissue Burns
  - Caused by current flowing through organs of the body
  - Caused by currents in excess of 1.5 amps
  - 3rd degree
  - Internal organs
  - **Typically fatal**

# One Type of Burn from Arc Flash

- Surface Burns
  - Caused by exposure to the arc flash
  - Can cause more surface burns if the initial arc flash ignites other material such as clothing
  - 1st degree to 3rd degree
  - **It has and may cause death!!!!!!**

# ELECTRICAL SAFETY



## How to prevent Shock?

1. Place Circuits in an Electrically Safe Working Conditions by Locking out and tagging out all sources

Chapter 1, Section 120.2(D) of NFPA  
70E-2004

2. Verifying that no electrical energy is present

Chapter 1, Section 120.2(D) of NFPA  
70E-2004

# Fire Ignition from Arc Flash

- The original and primary mission of the NFPA
  - Primarily covered by installation standards contained in the National Electric Code- NFPA 70
  - The incidence of fire ignition has dropped dramatically since the advent of the NEC and the acceptance of installation requirements within the industry.
- The NFPA 70 - NEC does not address the other hazards of electricity.



# Exposure to Danger

- The National Electric Code protects individuals from shock hazards under normal conditions.
- It is not designed to protect us from **abnormal** conditions.
- We need additional policies to protect from **abnormal** conditions.



# Conditions

- Normal Conditions
  - Panel Covers In Place.
  - Equipment plugged in normally.
  - Normal, designed protection in place.
- **Abnormal Conditions**
  - **Panel covers removed.**
  - **Equipment temporarily wired.**
  - **Normal designed protection such as guards, limits switches, etc. not in place.**

# Protection from Abnormal Conditions

## The Company

- NFPA 70 E
- OSHA
- Electrical Safety Procedures Manual
- Electrical Safety Training

## • You

- The first line of defense
- Only you can truly keep you safe
- Implement Safety Procedures Outlined in Safety Manual
- Only you can ensure that you go home at night

# Old School

- Electricians have always recognized the shock hazards of electricity. We are taught:
  - To consider circuits to be energized
  - To insulate and protect our selves
  - Stand to one side if you suspect an arc flash/blast

# New School

- Arc Flash and Blast hazards were not formally studied until 1993 (IEEE 1584 began study)
- Electricians have not experienced arc flash and blasts to the same frequency as electrical shock.
- We have not been trained how to avoid and minimize arc flash and blasts in the past.
- The Electrical Energized Work Practices outlined in NFPA 70E incorporates measures to help avoid or minimize damage from arc flash.

## *Practical Solution Guide to Arc Flash Hazards*



Figure 1.1: (a) Arc blast in box<sup>2</sup> ; (b) Arcing fault in electrical panel board



NOTES ARE FROM *Practical Solution Guide to Arc Flash Hazards*,  
By Chet Davis, P.E.; Conrad St. Pierre; David Castor, P.E.; Robert Luo,  
PhD; Satish Shrestha

- Electric arcs produce the highest temperatures on earth –up to 35,000 degrees Fahrenheit (4 x temp of the sun)!
- The intense heat from arc causes the sudden expansion of air that results in a blast with very strong air pressure (Lightning is a natural arc).
- All known materials are vaporized at this temperature. (Copper expands 67,000 times, Water 1670 times).



NOTES ARE FROM *Practical Solution Guide to Arc Flash Hazards*,  
By Chet Davis, P.E.; Conrad St. Pierre; David Castor, P.E.; Robert Luo,  
PhD; Satish Shrestha

- Arcs in enclosures, such as a Motor Control Centers (MCCs) or switchgear, magnify blast and energy transmitted as the blast is forced to the open side of the enclosure.
- Arcs spray droplets of molten metal at high-speed pressure. Blast shrapnel can penetrate the body.
- Blast pressure waves have thrown workers across rooms and knocked them off ladders. Pressure on the chest can be higher than 2000 lbs/ sq. ft.



NOTES ARE FROM *Practical Solution Guide to Arc Flash Hazards*,  
By Chet Davis, P.E.; Conrad St. Pierre; David Castor, P.E.; Robert Luo,  
PhD; Satish Shrestha

- Clothing can be ignited several feet away. Clothed areas can be burned more severely than exposed skin.
- Hearing loss from sound blast. The sound can have a magnitude as high as 140 dB at a distance of 2 feet from the arc.
- Energy released is a function of:
  - system voltage
  - fault current magnitude
  - fault duration

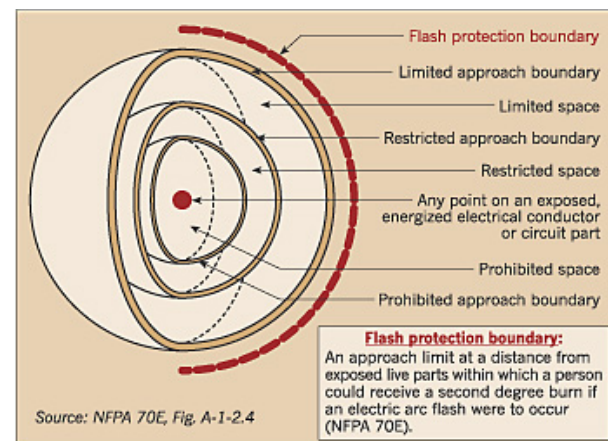
# How to protect against Shock and Arc Flash/Blast?

## Chapter 1, Section 130 of NFPA 70E-2004

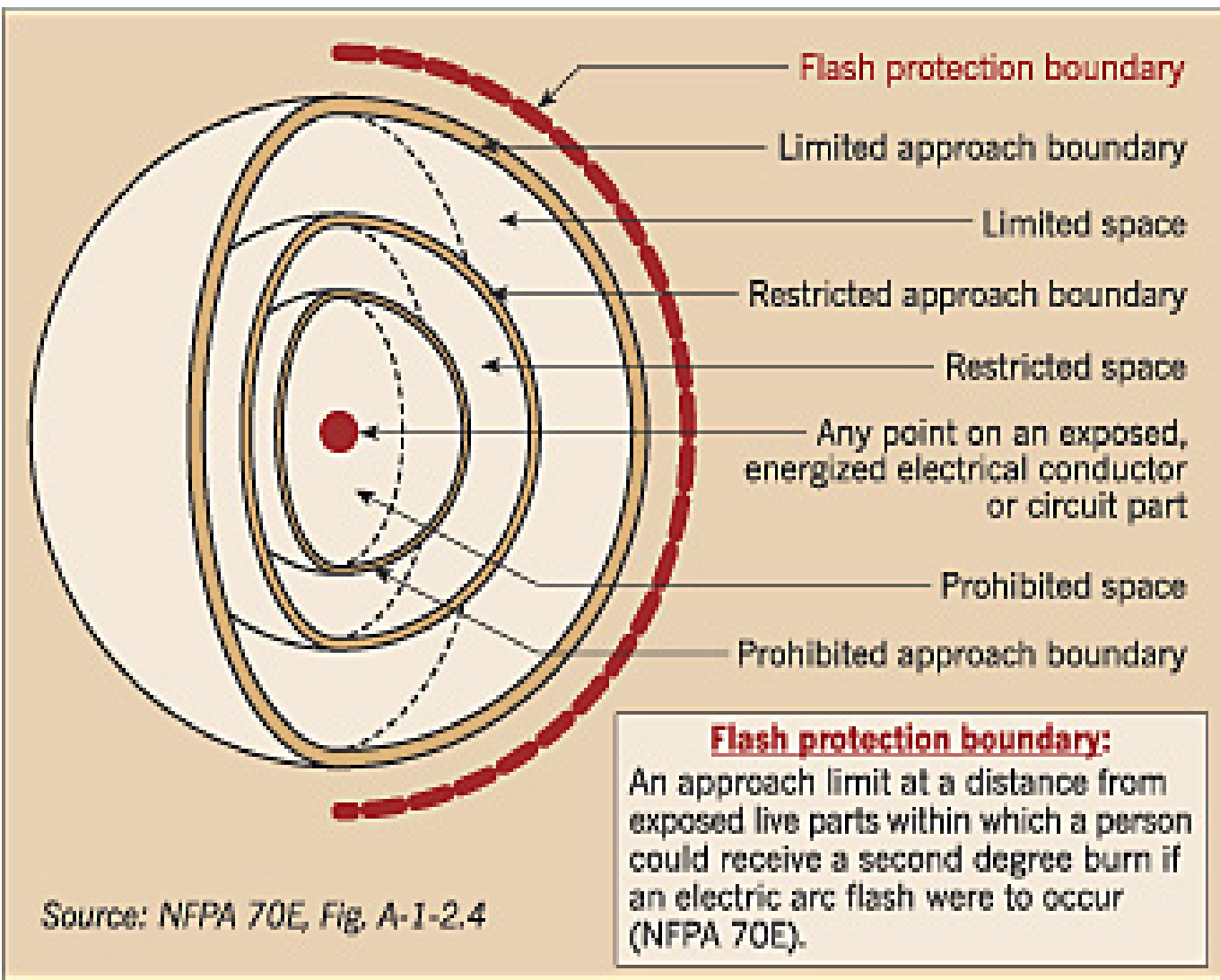
1. Justification for Live Work
2. Work Permits Secured if Applicable
3. Approach Boundaries Established

### A. Shock Protection

- a. Limited Boundary
- b. Restricted Boundary
- c. Prohibited Boundary

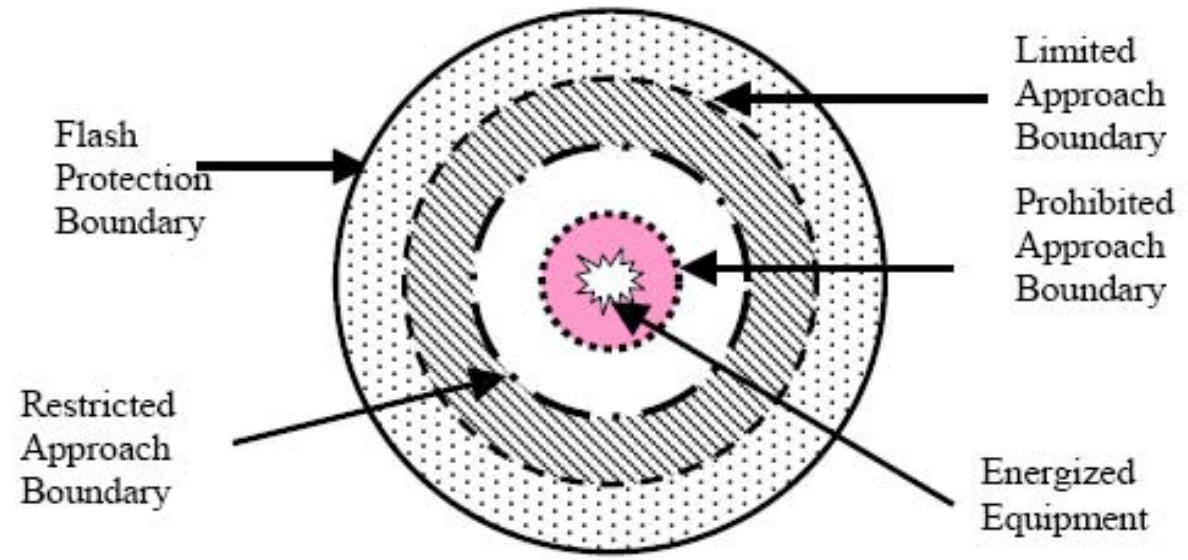


### B. Flash Protection – ONE BOUNDARY



Source: NFPA 70E, Fig. A-1-2.4

## *Practical Solution Guide to Arc Flash Hazards*



**Figure 1.2: Protection boundaries**



# *Approach Boundaries*



## **NPFA 70E-2004 Ch. 1, Section 130.2 p24-25**

### *Limited Approach Boundary*

entered only by qualified persons or unqualified persons that have been advised and are escorted by a qualified person

### *Restricted Approach Boundary*

entered only by qualified persons required to use shock protection techniques and PPE

### *Prohibited Approach Boundary*

entered only by qualified persons requiring same protection as if direct contact with live part

### *Flash Protection Boundary*

linear distance to prevent any more than 2<sup>nd</sup> degree burns from a potential arc-flash (Typically 4 feet)

SEE TABLE 130.2(C) on p. 25



# SHOCK Hazard Analysis



*Ch. 1, Sec. 130.2 (A) Shock Hazard Analysis.*

**70E-2004 P. 24**

*“Shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the PPE necessary in order to minimize the possibility of electric shock to personnel.”*

*What is required?*

- 1. Determine the Operating Voltage of the System*
- 2. Determine Shock Protection Boundaries*
- 3. Determine the Personnel Protective Equipment*



# SHOCK Hazard Analysis alliance

An OSHA Cooperative Program

## *How to Comply with NFPA 70E?*

- 1. Determine the Operating Voltage.*
- 2. Determine the Three Shock Protection Boundaries by using Table 130.2(C) of NFPA 70E-2004 on P. 25*
  - a. Limited Approach Boundary*
    - 10 ft for 480 V for movable energized object*
    - 3 ft 6 in. for fixed energized object*
  - b. Restricted Approach Boundary*
    - 12 in. for 480 V*
  - c. Prohibited Approach Boundary*
    - 1 in. for 480 V*



# SHOCK Hazard



## *How to Comply with NFPA 70E?*

### *3. Determine the Personnel Protective Equipment :*

#### *a. Determine Risk Category from Table*

*130.7(C)(9)(a) on NFPA 70E-2004 on P. 29*

#### *b. Determine Specific PPE & Clothing from Table*

*130.7(C)(10) of NFPA 70E-2004 on P. 33*

***OR***

# Flash Hazard

*Ch. 1, Sec. 130.3 Flash Hazard Analysis. “A flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection Boundary and the personal protective equipment that people within the Flash Protection Boundary shall use.”*

***How to Comply with NFPA 70E for FLASH Protection?***

- 1. Determine the Flash Protection Boundary***
- 2. Determine the incident energy exposure level***
- 3. Determine the Protective Clothing and PPE***



# Flash Hazard



## How to Comply with NFPA 70E for FLASH Protection?

### 1. Determine Flash Protection Boundary:

*Calculate using the  $I_{Short-Circuit\ Amperes}$  & the clearing time for the overcurrent protection*

*(see Formula below & on Page 25 of NFPA 70E-2004*

*OR default to four feet - 600 V or less @ 300 kA cycles per 130.3(A) of NFPA 70E-2004)*

### Flash Protection Boundary Formula (600 V or less)

$$D_C = [53 \times MVA \times t]^{1/2}$$

where  $D_c$  = Arc Flash Boundary (AFB) in Feet

$MVA$  = Transformer capacity in MVA

$t$  = clearing time in seconds

## Second Degree Burn Threshold

# 1.2 cal/cm<sup>2</sup>

# Flash Hazard Analysis

## *2. Determine the Incident Energy Level :*

*Calculate incident energy exposure level for the distance between worker's face & chest from the potential arc source (18" typical) OR use 130.7(C)(9) and 130.7(C)(10)*

### *Incident energy formula for Arc in a Cubic Box :*

$$E_{MB} = 1038.7 D_A^{-1.4738} t_A [0.0093 F^2 - 0.3453 F + 5.9675]$$

Where  $E_{MB}$  = cal/cm<sup>2</sup> in 20 inch Cubic Box

$D_A$  = distance from electrode in inches  
(typically this value would be 18")

$t_A$  = clearing time

$F$  =  $I_{\text{short-Circuit}}$  Amperes available (range of 16 kA to 50 kA)

# Flash Hazard Analysis

## *3. Determine the Proper PPE :*

*Once the incident energy is determined, the PPE has to have a rating equal to or greater than the incident energy available. If the alternate method of*

*using 130.7(C)(9) and 130.7(C)(10), then the proper PPE is selected from 130.7(C)(10) of NFPA 70E-2004.*

*Example 1 - An Electrician is to remove the covers to measure the voltage on a panelboard operating at 480 V.*

*Table 130.7(C)(9) > Hazard Risk Category (HRC) = 2\*  
(V-Rated Gloves and V-Rated Tools Required )*

*Table 130.7(C)(10) Specifies the following Required:*

- \* Untreated Natural Fiber T-Shirt & Undergarments*
- \* FR (8 cal/cm<sup>2</sup>) Long Sleeve Shirt & Pants*
- \* Hard Hat*
- \* Safety Glasses or Safety Goggles*
- \* Arc-Rated Face Shield w/ Flash Hood or Tube Sock*
- \* Hearing Protection*
- \* Leather Gloves*
- \* Leather Work Shoes*

***ELECTRICAL HOT WORK PERMIT REQUIRED? (Ans: NO)***



# Flash Hazard Analysis alliance

An OSHA Cooperative Program

*Example 2 - An electrician is to operate a circuit breaker in the main switchgear (with all of the covers on the switchgear) to de-energize a circuit that is operating at 480 V for lock-out tagout.*

*Table 130.7(C)(9) > Hazard Risk Category (HRC) = 0  
(No V-Rated Gloves & No V-Rated Tools Required )*

*Table 130.7(C)(10) Specifies the following Required:*

- \* Untreated Natural Fiber long-sleeve shirt & pants*
- \* Safety Glasses*

***NEXT STEP IS TO VERIFY VOLTAGE IS OFF!***

***Electrician goes to machine disconnect to open and test for presence of voltage – What is the HRC level? (Ans: 2\*)***

***ELECTRICAL HOT WORK PERMIT REQUIRED? (Ans: NO)***

*Example 3 - An electrician is to operate a circuit breaker in the main switchgear (with some of the covers removed from the switchgear) to de-energize a circuit that is operating at 480 V for lock-out tagout.*

*Table 130.7(C)(9) > Hazard Risk Category (HRC) = 1  
(No V-Rated Gloves & No V-Rated Tools Required )*

*Table 130.7(C)(10) Specifies the following Required:*

- \* Untreated Natural Fiber pants*
- \* FR pants and long sleeve shirt*
- \* Hard Hat*
- \* Safety Glasses*

***NEXT STEP IS TO VERIFY VOLTAGE IS OFF!***

***Electrician goes to machine disconnect to open and test for presence of voltage – What is the HRC level? (Ans: 2\*)***

***ELECTRICAL HOT WORK PERMIT REQUIRED? (Ans: NO)***

***Example 4 - An electrician is to remove the covers on a panelboard to troubleshoot a 20 A lighting circuit that is not working. The circuit is operating at 208/120 V.***

***Table 130.7(C)(9) > Hazard Risk Category (HRC) = 1  
(V-Rated Gloves & V-Rated Tools Required )***

***Table 130.7(C)(10) Specifies the following Required:***

- \* Untreated Natural Fiber pants***
- \* FR pants and long sleeve shirt***
- \* Hard Hat***
- \* Safety Glasses***

***ELECTRICAL HOT WORK PERMIT REQUIRED? (Ans: NO)***

*Example 5 - An electrician is to install a 100 A, 480 V I-Line circuit breaker on a panelboard for a new bailer machine. If the panel is shutdown, all the lines will stop and the warehouse will be without lighting.*

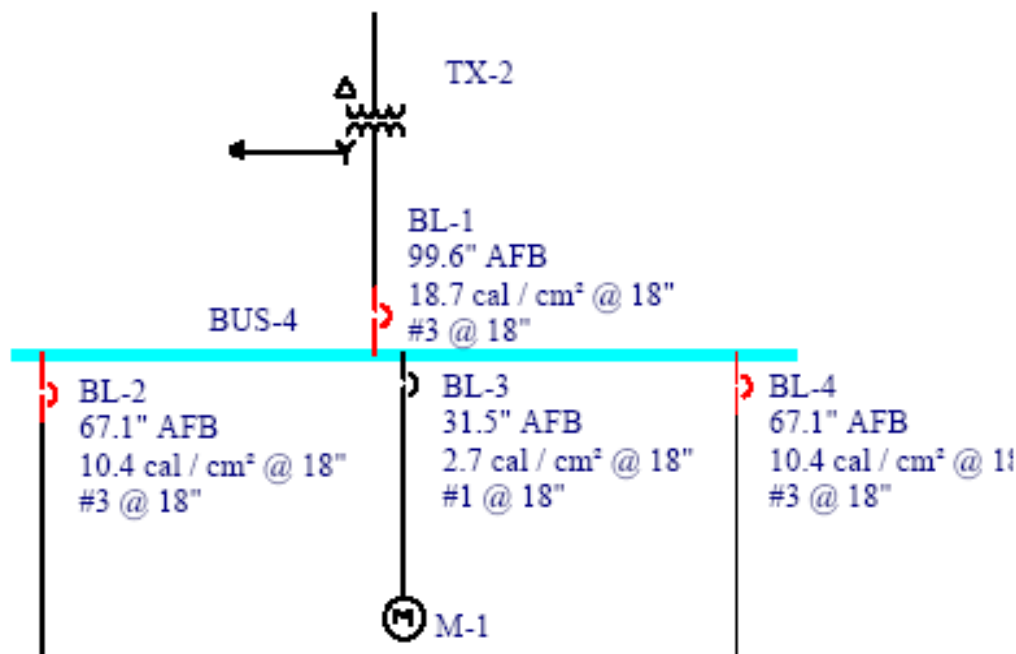
*Table 130.7(C)(9) > Hazard Risk Category (HRC) = 2\*  
(V-Rated Gloves & V-Rated Tools Required)*

*Table 130.7(C)(10) Specifies the following Required:*

- \* Untreated Natural Fiber T-Shirt & Undergarments*
- \* FR (8 cal/cm<sup>2</sup>) Long Sleeve Shirt & Pants*
- \* Hard Hat*
- \* Safety Glasses or Safety Goggles*
- \* Arc-Rated Face Shield w/ Flash Hood or Tube Sock*
- \* Hearing Protection*
- \* Leather Gloves*
- \* Leather Work Shoes*

***ELECTRICAL HOT WORK PERMIT REQUIRED? (Ans: YES)***

# Flash Hazard Analysis



**Figure 1.3: Example of arc flash hazard calculation results on one-line diagram in the integrated software EasyPower®.**

Figure from: *Practical Solution Guide to Arc Flash Hazards*,

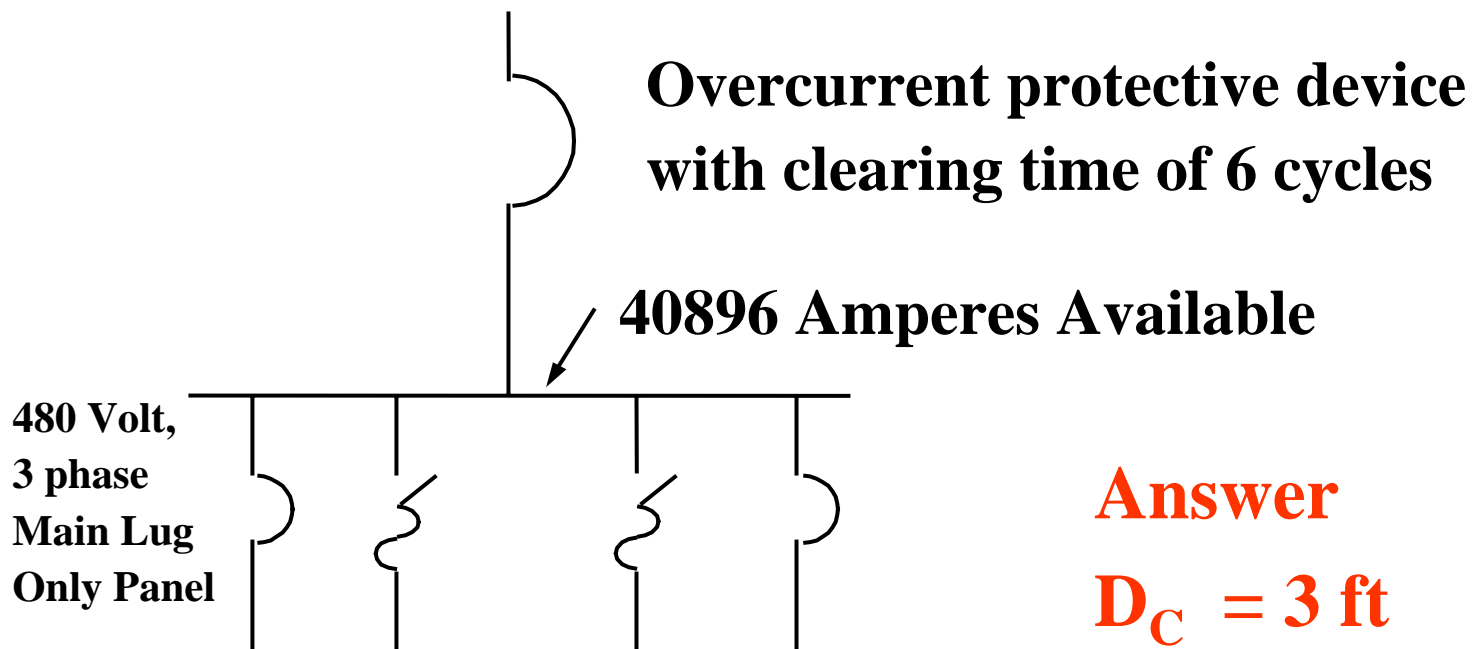
By Chet Davis, P.E.; Conrad St. Pierre; David Castor, P.E.; Robert Luo, PhD; Satish Shrestha

## Flash Hazard Analysis -Example 2

This Example Provided Bussmann ®

- Flash Protection Boundary Calculation*

Circuit using non-current limiting circuit breaker



## Flash Hazard Analysis - Example 2

This Example Provided Bussmann ®

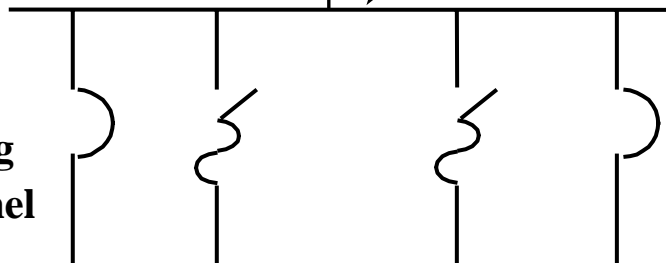
- Flash Protection Boundary* Calculation

Circuit using current limiting fuses

**Class J, 200 A fuse  
clearing time of 1/4 cycle under  
short circuit conditions.**

**40896 Amperes Available  
6000 Equivalent RMS Let-Through**

480 Volt,  
3 phase  
Main Lug  
Only Panel



**Answer**

$$D_C = .23 \text{ ft}$$



# Flash Hazard Analysis



This Example Provided Bussmann ®

## *Incident Energy Calculation*

**Formula: Based on CUBIC BOX**

$$E_{MB} = 1038.7 D_B^{-1.4738} t_A [0.0093F^2 - .3453F + 5.9675] \text{ cal/cm}^2$$

$E_{MB}$  = Incident Energy (cal/cm<sup>2</sup>)

$D_B$  = Distance, (in.) [*for Distances  $\geq 18$  inches*]

$t_A$  = Arc Duration, (sec.)

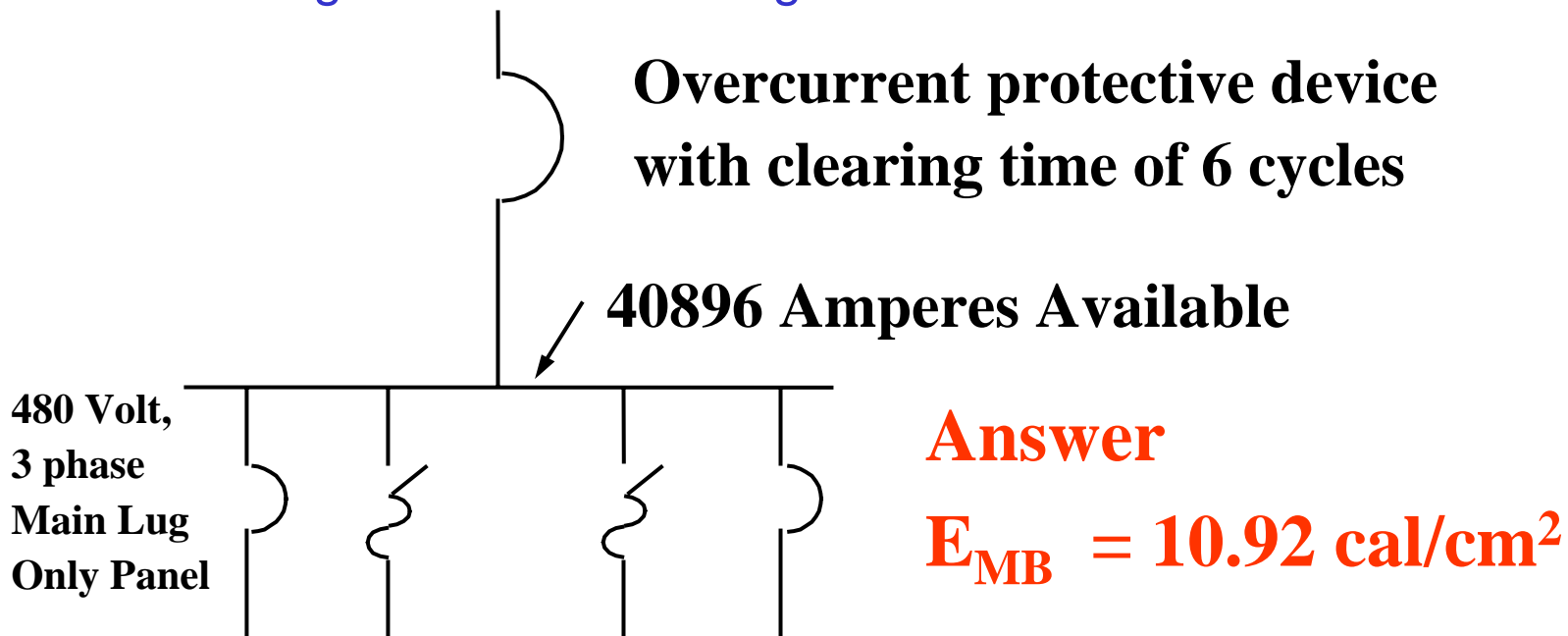
$F$  = Bolted Fault Short Circuit Current [16KA to 50kA]

# Flash Hazard Analysis - Example 2

This Example Provided Bussmann ®

## Incident Energy Calculation @ 18"

Circuit using non-current limiting circuit breaker



**Answer**

$$E_{MB} = 10.92 \text{ cal/cm}^2$$



# Flash Hazard Analysis

This Example Provided Bussmann ®

*Incident Energy Calculation @ 18"*

Example 2: **40896 amps** of available fault current, 480 volt 3 phase system, Non-current limiting overcurrent device **6 cycle (0.1 sec)** opening time.

$$E_{MB} = 1038.7 D_B^{-1.4738} t_A [0.0093F^2 - .3453F + 5.9675]$$

$$E_{MB} = 1038.7 (18)^{-1.4738} (.1) [0.0093(41)^2 - .3453(41) + 5.9675]$$

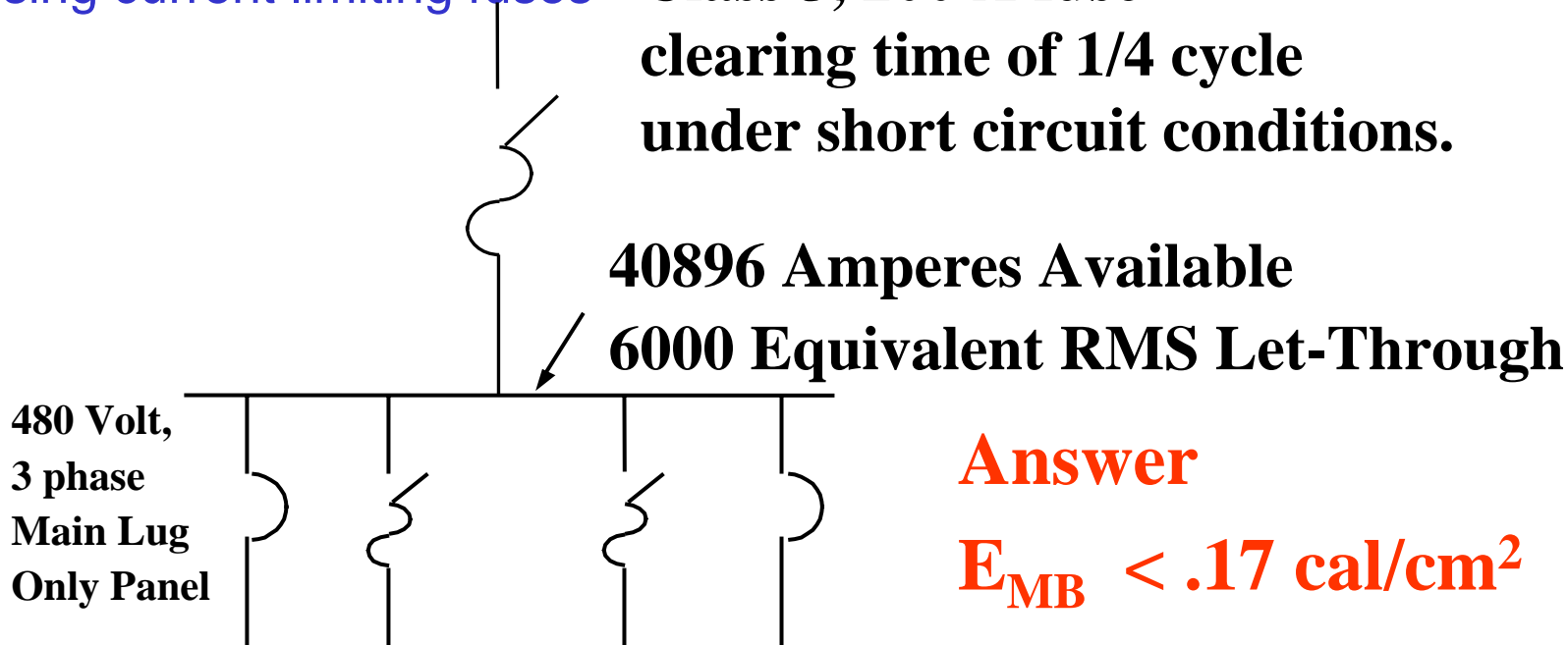
$$E_{MB} = 10.92 \text{ cal/cm}^2$$

This Example Provided Bussmann ®

## Incident Energy Calculation @ 18"

Circuit using current limiting fuses

**Class J, 200 A fuse  
clearing time of 1/4 cycle  
under short circuit conditions.**



**Answer**

$$E_{MB} < .17 \text{ cal/cm}^2$$



# Section 110.16 of the 2002 NEC<sup>®</sup> Requires Arc Flash Hazard Labels



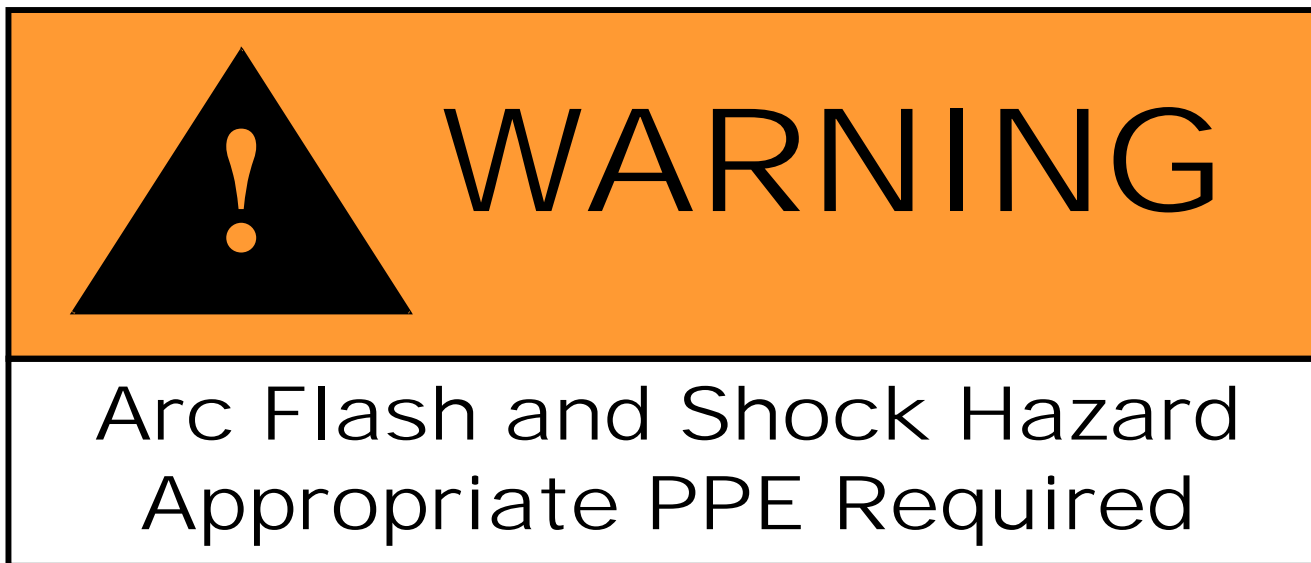
# Arc Flash Labeling Required by NEC



**110.16 Flash Protection.** Switchboards, panelboards, industrial control panels, and motor control centers in other than dwelling occupancies, that 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.

FPN No. 1: NFPA 70E-2000, *Electrical Safety Requirements for Employee Workplaces*, provides assistance in determining severity of potential exposure, planning safe work practices, and selecting personal protective equipment.

FPN No. 2: ANSI Z535.4-1998, *Product Safety Signs and Labels*, provides guidelines for the design of safety signs and labels for application to products.



Courtesy E.I. du Pont de Nemours & Co.



# WARNING

## Arc Flash and Shock Hazard Appropriate PPE Required

48 inch Flash Hazard Boundary  
7.4 cal/cm<sup>2</sup> Flash Hazard at 18 inches  
HRC 2 PPE Level, FR Clothes, Shield, Hard Hat,  
Leather Gloves, Leather Shoes, Hearing Protection  
480 VAC Shock Hazard when Cover is removed  
42 inch Limited Approach  
12 inch Restricted Approach - 500 V Class 00 Gloves  
1 inch Prohibited Approach - 500 V Class 00 Gloves  
Equipment Name: **Pump # 2 Starter**

Courtesy E.I. du Pont de Nemours & Co.



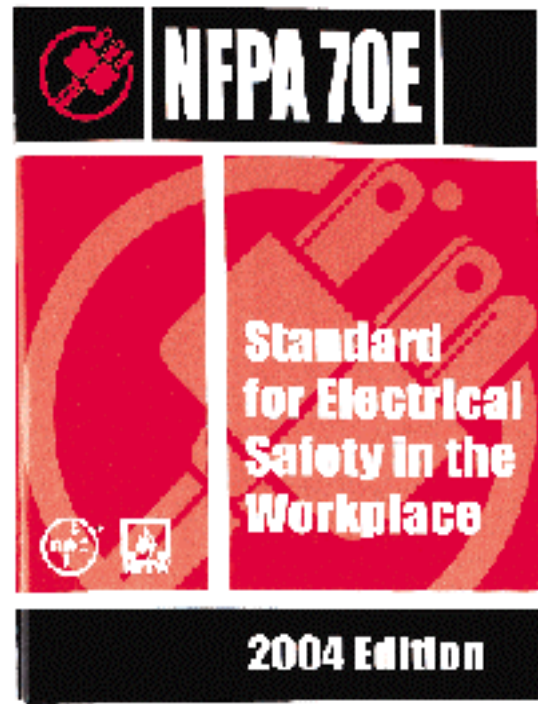
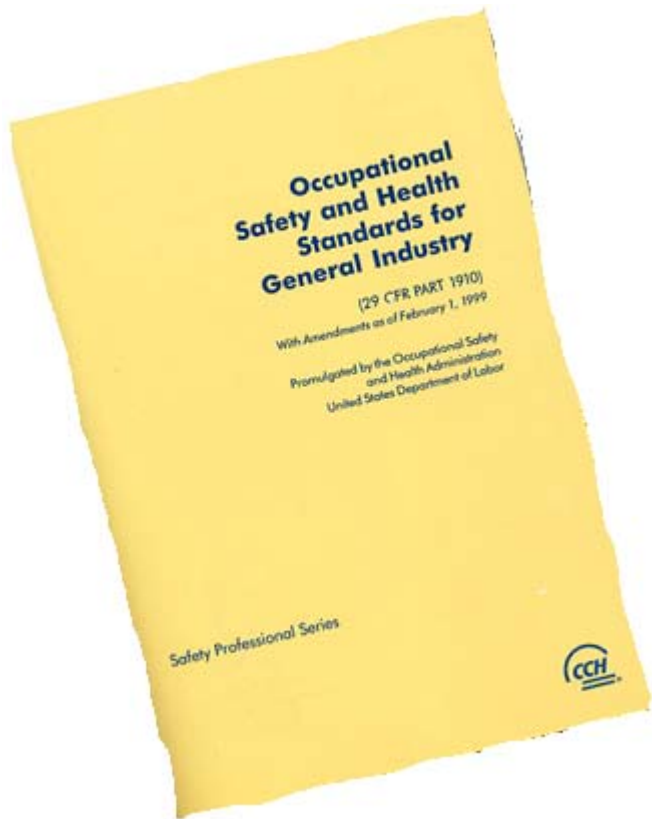
# WARNING

## Arc Flash and Shock Hazard Appropriate PPE Required

- 24 inch Flash Hazard Boundary
- 3 cal/cm<sup>2</sup> Flash Hazard at 18 inches
- HRC 1 PPE Level, FR Pants & Shirt  
4 cal/cm<sup>2</sup>
- 480 VAC Shock Hazard when Cover is removed
- 42 inch Limited Approach
- 12 inch Restricted Approach - 500 V Class 00 Gloves
- 1 inch Prohibited Approach - 500 V Class 00 Gloves

**Equipment Name:** Pump # 1 Starter

# What Are the OSHA Regulations and NFPA 70E Requirements for Working on “Live” Equipment?



# NFPA 70E: Safety in Workplace

## OSHA 1910.333 (a) (1) & NFPA 70E 130.1

*Qualified electrical workers shall not be asked to work on equipment that is “hot” or “live” except for two demonstrable reasons :*

*1. Deenergizing introduces additional or increased hazards*  
*e.g. \* cutting ventilation to a hazardous location*  
*\* emergency alarm systems*

*or*

*2. Infeasible due to equipment design or operational limitations*  
*e.g. \* voltage testing for diagnostics*  
*\* start up testing*

## Safety-Related Work Practices

### 1910.333 Selection & use of work practices

- (a) General. Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contact, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards



## Safety-Related Work Practices

### 1910.335 Safe guards for personnel protection

(a) (2) (B) (ii) Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur.



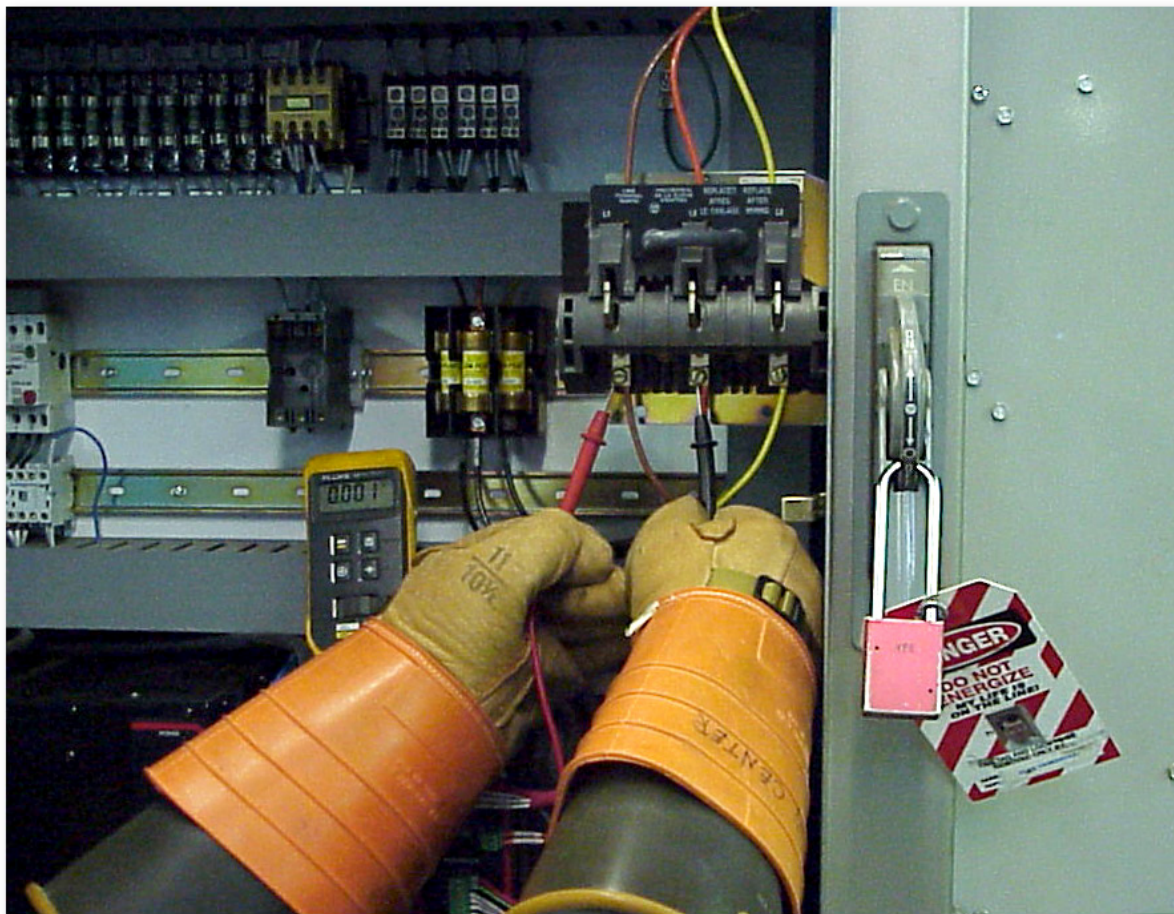
# Who's Responsible for Safety?

**The “Employer” is responsible for**  
OSHA requirements  
Electrical Safety Program  
Safety Policies and Procedures  
Safety Training and Retraining

**The “Employee” is responsible for**  
Implementing procedures  
[NFPA 70E-110.3(B)]

**The “Owner” and Contractors are both**  
**responsible to Coordinate and Document**  
**Harzards and Safety Procedures**  
Contractors on site and visa versa [NFPA  
70E-110.4(B)]

# Proper Safety Procedures Saves Our People!



# Response to an Electrical Accident

Personnel that are Trained in CPR  
should be identified and available  
when work near or on energized parts  
is being performed

# Response to an Electrical Accident

The first step must be to  
“TURN THE POWER OFF”

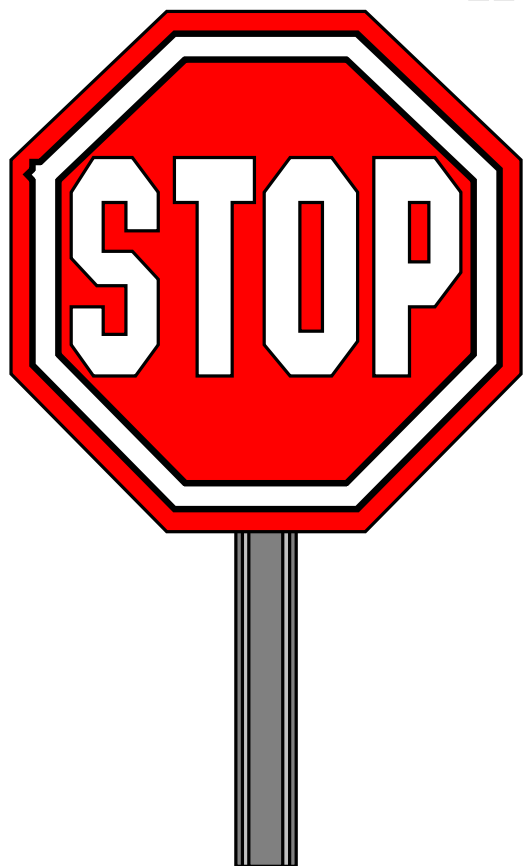
# Steps to Take If An Electrical Accident Happens

- **Remove the Immediate Hazard: turn Off the Power**
- **Remember that Speed is Essential**
- **Extinguish flames**
- **Call for Help (911)**
- **Begin CPR & First Aid**
- **First Aid**
  - **Cool the burn with water**
  - **Do not attempt to remove burned clothing**
  - **Elevate burned limbs**
  - **Handle the victim with care**
  - **Treat for shock**
    - **Maintain body temperature**
    - **Do not give anything by mouth**

# C P R

Personnel that work near or on energized parts should be trained in CPR.

# What is the best way to prevent the hazards of electricity?



- **S**top - Before Action
  - **T**hink - Risks/Hazards
  - **O**ptions - LOTO
  - **P**rotection - Proper PPE
- 
- *Avoid energized circuits is the Safest Way!*