

IEEE-IAS Electrical Safety in the Workplace

Dave Rewitzer, PE, CEM

OSHA Authorized General Industry Trainer

David Rewitzer, PE, CEM

Licensed
Professional
Engineer
(TN & GA)

- More than 25 years experience in power distribution
 - Worked his way up from an electrician's helper
 - Joined PSSG in 2007, currently manages the group
- BSEE and MSEE electrical engineering degrees
- Extensive experience performing power system studies
 - Short circuit, coordination, arc flash hazard, and energy management analysis
- Conducts arc flash hazard analysis, energy management, and power quality training
- Professional associations include
 - Voting committee for the IEEE 1584 – IEEE Guide for Performing Arc Flash Hazard Calculations
 - IEEE IAS – Atlanta Chapter Secretary
 - National Safety Council committee

Introduction

- Please silence cell phones
 - If you must take a call, please go out of room
- Exit the building the way you came in
- Some videos and pictures might be disturbing

Statistics



Occupational Fatalities

2011-2016 Occupational Fatalities by Event/Type

Year	2011	2012	2013	2014	2015	2016	Total
Total Occupational Fatalities	4,693	4,628	4,585	4,821	4,836	5,575	29,138
Type of Event of Exposure							
Transportation Incidents	1,937	1,923	1,865	1,984	2,054	2,083	11,846
Slips, Trips, and Falls	681	704	724	818	800	849	4,576
Violence/Injuries by Persons/Animals	791	603	773	765	703	866	4,501
Contact with Objects and Equipment	710	723	721	715	722	761	4,352
Exposure to Electricity	174	156	141	154	134	154	913
Fire or Explosion	144	122	149	137	121	88	761

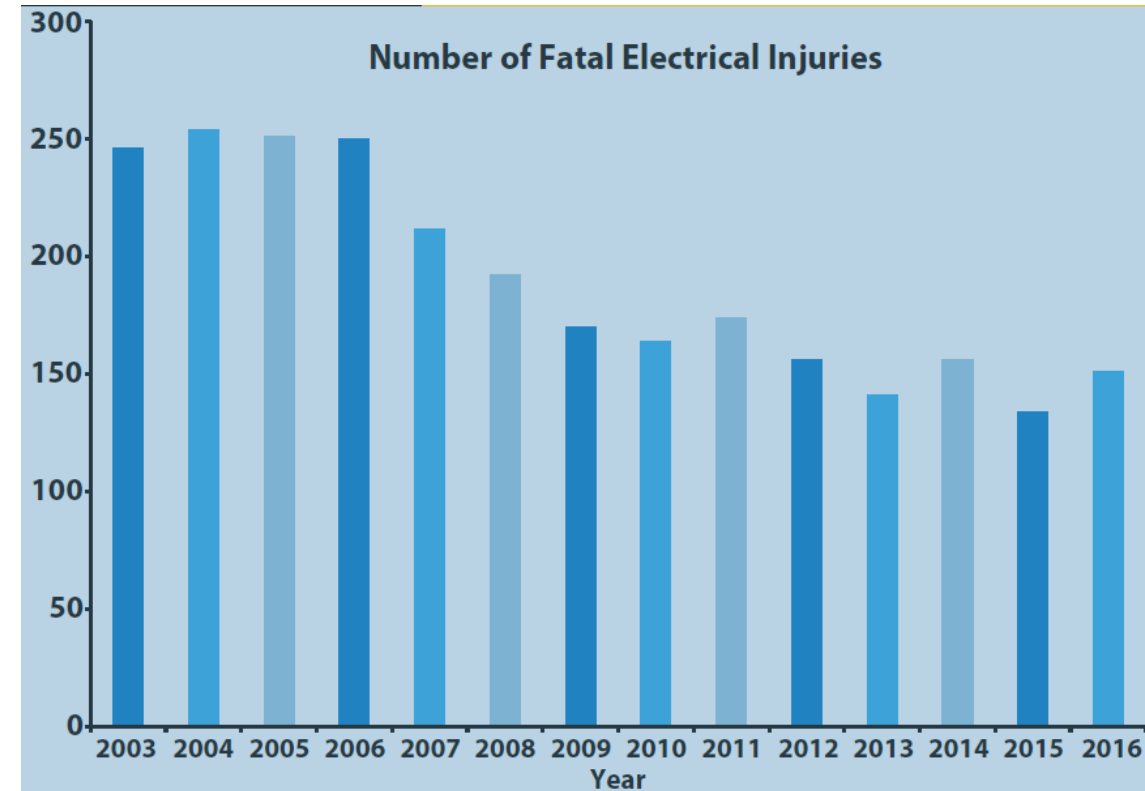
Note: 2017 Statistics will be published in autumn 2018

ESW 2018-39-Reframing our view of workplace electrical injuries and BLR National Census of Fatal Occupational Injuries 2016

Electrical Deaths – By the Numbers

From 2003-2016

- Steady drop from 2006 until 2010
- 2011-2016 numbers fluctuated up and down
 - Down 13% in 2015 from 2014
 - Up 15% in 2016 from 2015
- 53% occur in construction
 - 47% non-construction



Electrical Fatalities

By the Numbers

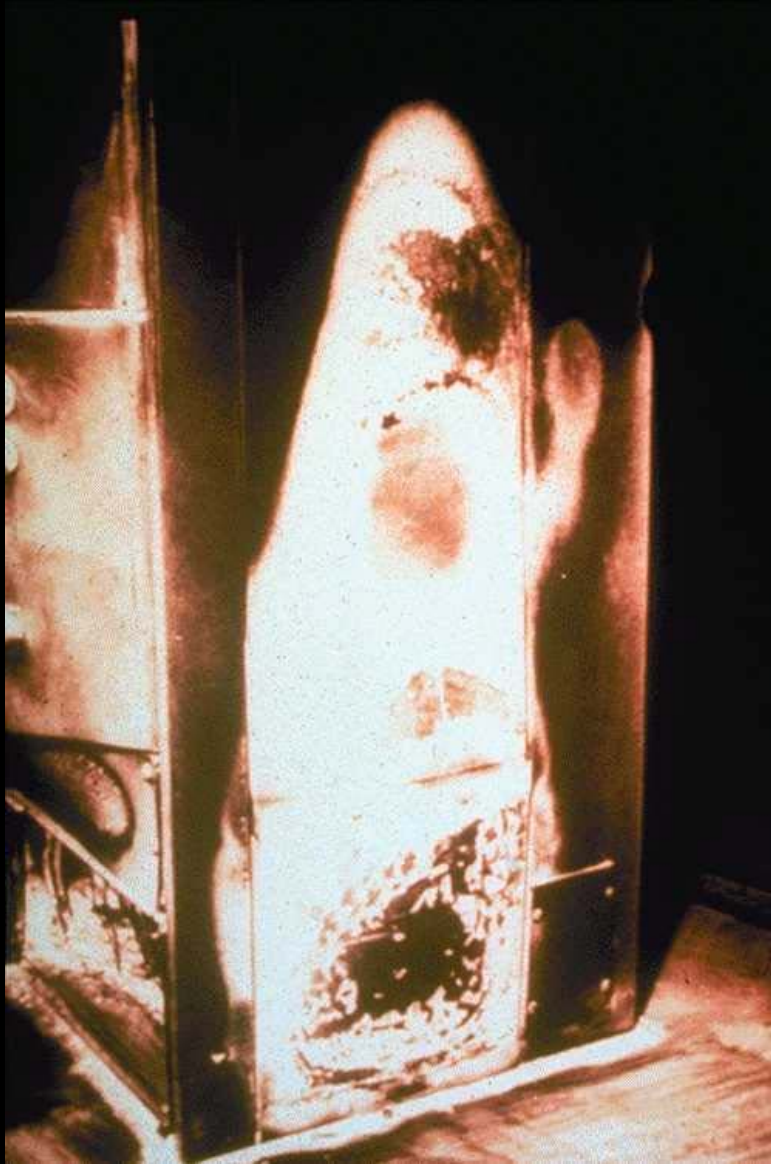
- 1990 – 2005 ≈ 250-300 electrical fatalities/year
- 2012 – 2016 ≈ 152 electrical fatalities/year
 - About 40% involve voltages under 250V
 - Misconception of electrical safety as a high voltage issue
 - About 40% involve overhead power line contact
 - Means 60% had nothing to do with overhead power lines!



Electrical Injuries to Fatalities

By the Numbers
Between 2003-
2009

- 20,033 electrical injuries / 1573 fatalities
 - For every 1 fatality there were ~13 injuries
- 1,718,219 fall injuries / 5279 fatalities
 - For every 1 fatality there were ~325 injuries
- Lack of training/experience
 - Highest proportion are employees with 10 or fewer workers
 - Younger workers 2.3x more likely to be killed than more experienced workers



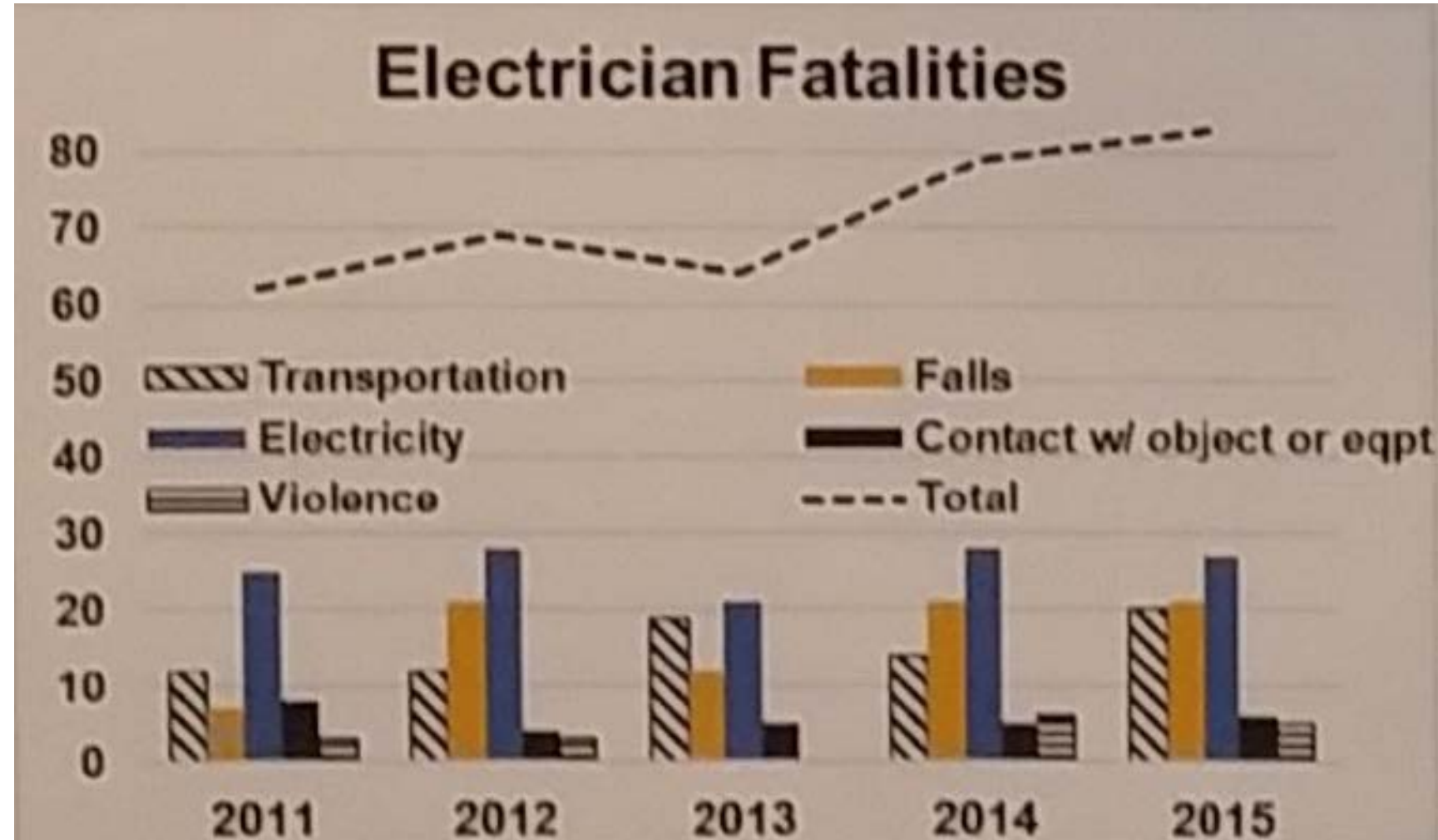
Electrical Shocks

By the Numbers 2009 breakdown

- 2009- 168 electrical fatalities
 - 99% were electrocutions
 - 70% were performing construction, repairing, or cleaning

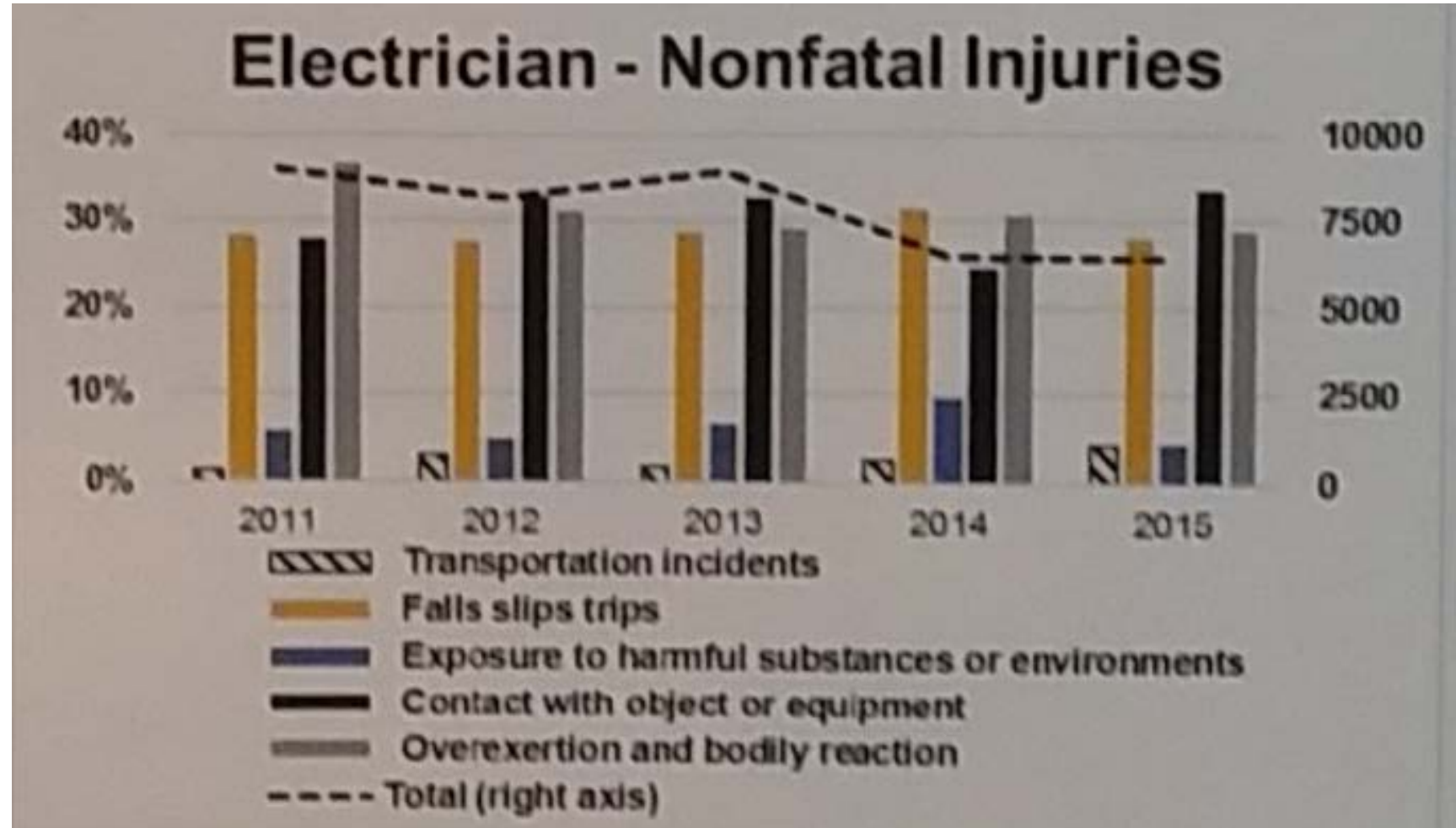
Electrical Fatalities

By the Numbers
Between 2011 and
2015



Electrical Nonfatal Injuries

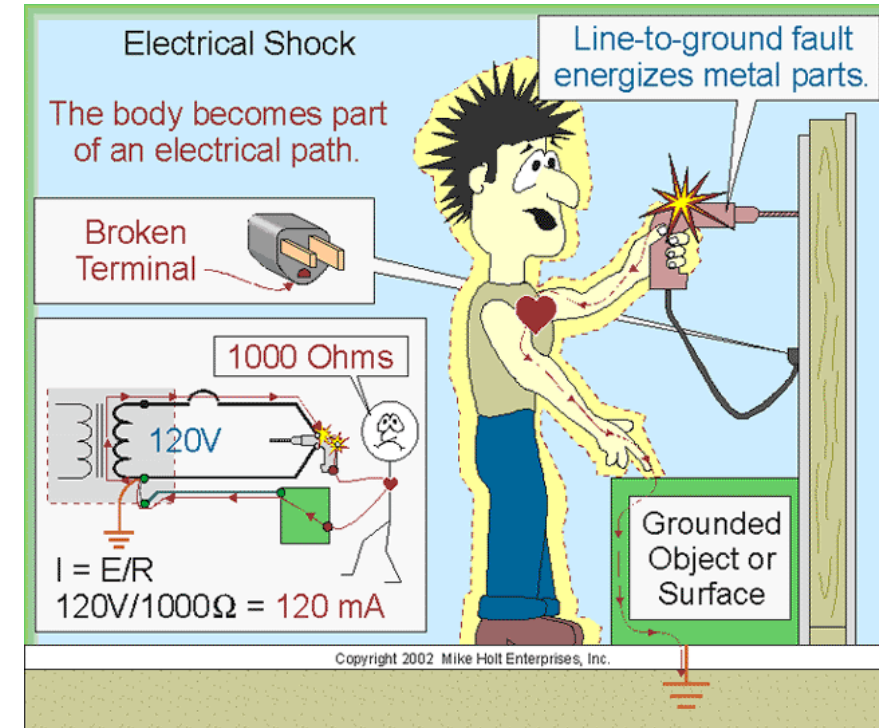
By the Numbers
Between 2011 and
2015



Electrical Shock

Current Affairs

- Amount of current depends on:
 - Type of circuit
 - Resistance of body
 - Pathway through body
 - Duration of contact
- Amount of current can cause:
 - Fibrillation
 - Damage to tissue at contact points
 - Muscle contraction
 - 60mA can be fatal



Human body is 2/3 water making it a good conductor!

Electrical Shocks

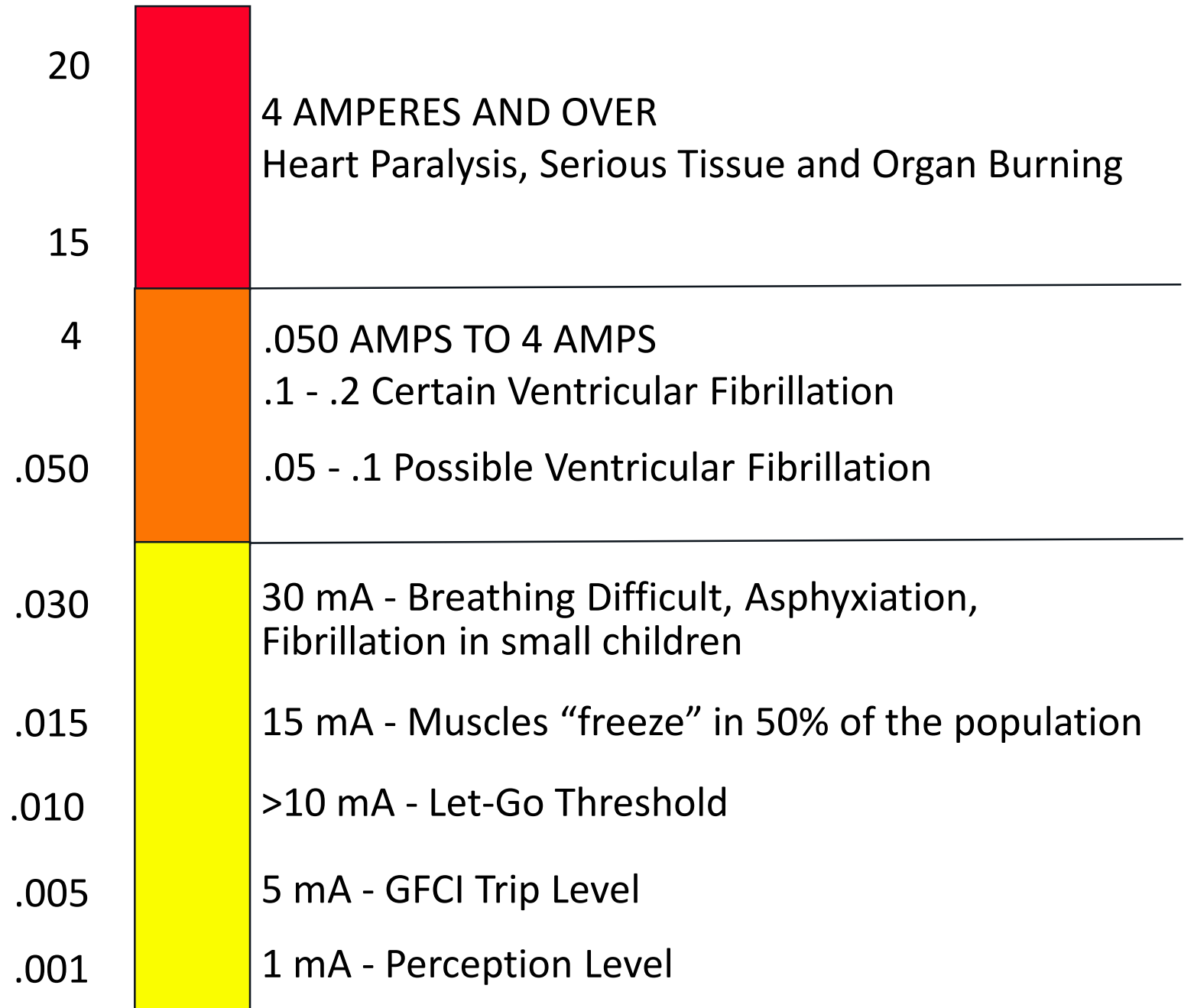
By the Numbers

Amount of current required to light a 7.5 Watt light bulb (@ 120V) across the chest (heart) will cause a fatality

$$7.5W/120V=.0625A \text{ or } 62mA$$

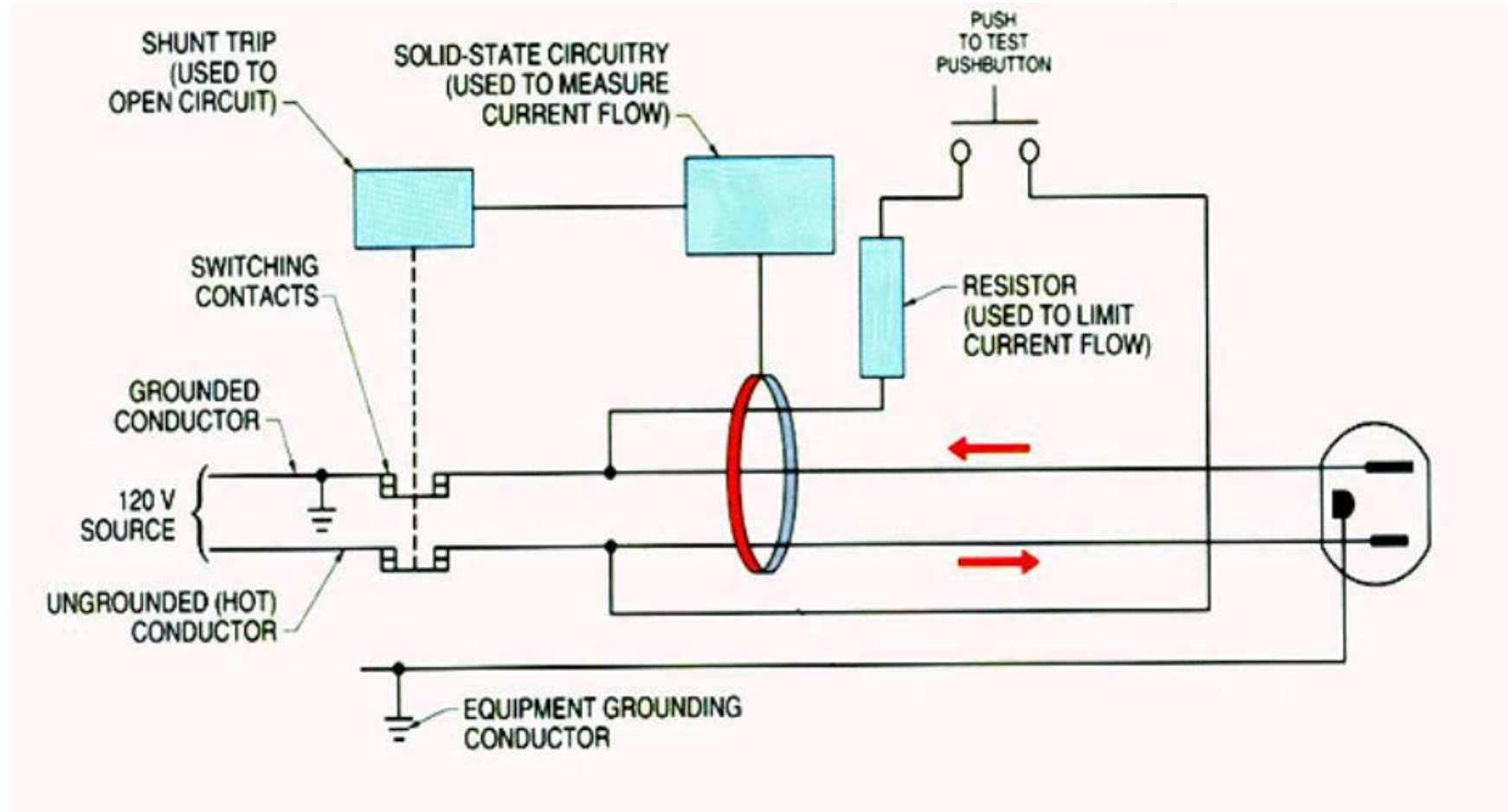
Electrical Shock

Hazard



GFCI

How does it work?



Electrical Shock

Case Study

- Cement Worker on side of highway cleaning up
 - Leaned over guard rail to pickup trash
 - He used the sign post to push himself back up
- Current entered in stomach and went through his right arm
 - Shocked for a brief moment
- Guard Rail post breached a lighting circuit containing 277V



277Volts/~1000ohms = 277mA < < < < DO THE MATH!!

*EC&M Magazine May 2015 "Forensic Casebook"

Electrical Shock

Case Study

- Symptoms – That Day
 - Very tired and less active rest of day
 - Heart racing most of day
- Symptoms – Next Few Months
 - Neuropathic pain
 - Sensory loss
 - General Fatigue
 - Numbness
- Symptoms – Long Term
 - Right Side Neuropathic pain



Electrical Shock

Case Study: Lessons Learned

Past experience is not a reliable predictor of injury since *minor* shocks can cause major internal injuries.

“Its not the last shock we should be concerned about but rather the next one”

Electrical Shock

Hazard

- Worker was shocked by a tool he was holding
- Same hand a few days later, had to cut open the arm to relieve pressure



Source-OSHA.gov

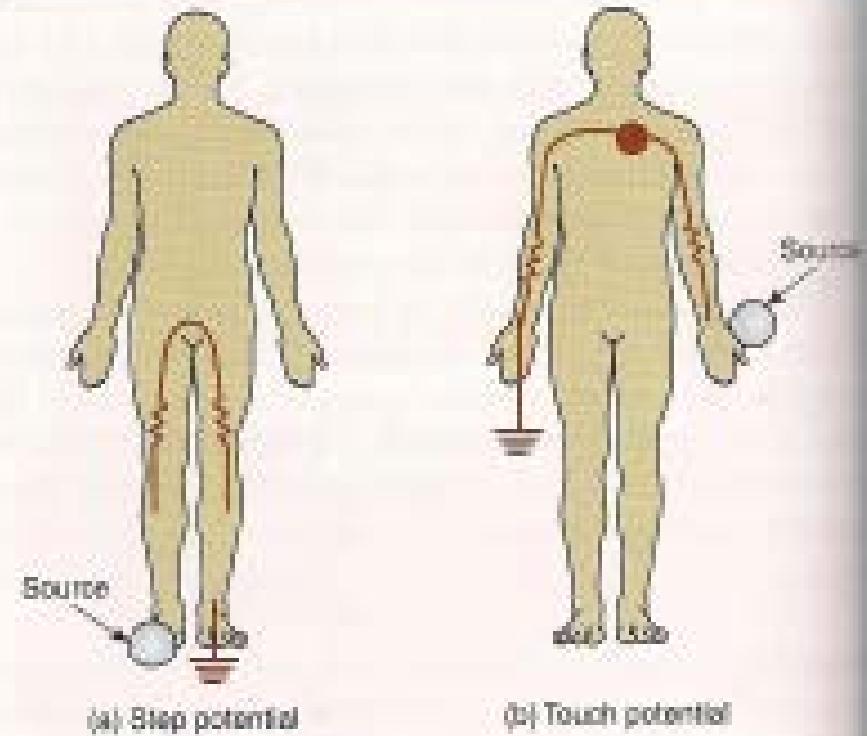
Electrical Shock

Damage Path

- The most damaging paths through the body are through the lungs, heart and brain.

Article 100 • Definitions

EXHIBIT 100.19 Step and touch potential for current flow path. (Adapted from *Safe Work Practices for Electricians*, by Ray A. Jones and Jane G. Jones, published by Jones and Bartlett, 2008)







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Live Leak

优酷

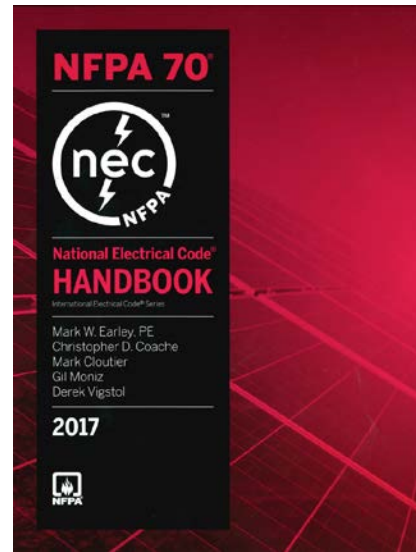
Camera 10

Arc Flash Hazards



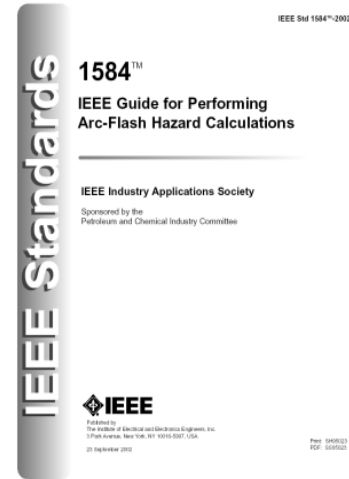
Arc-Flash Hazards

The Standards



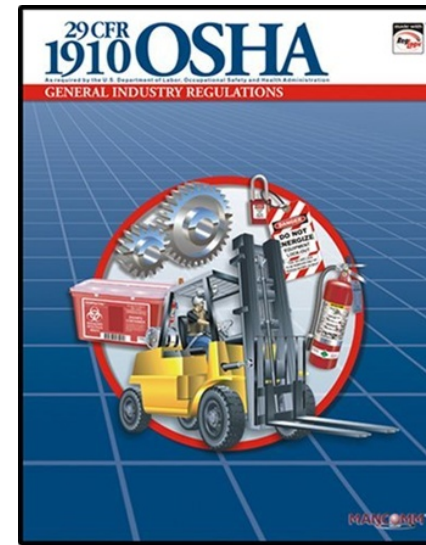
NEC 2017
(NFPA 70)

Governs Electrical
Installations



IEEE 1584b
2011

Guide for Performing
Arc Flash Hazard
Calculations



OSHA 29 CFR
Part 1910

OSHA Standards



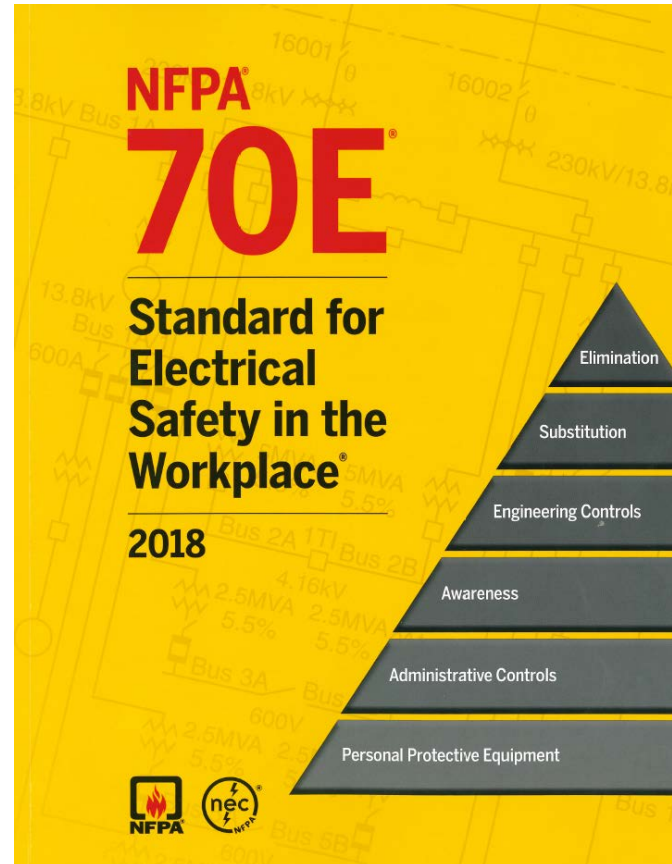
NFPA 70E 2018

Governs Employee
Workplace Safety


Arc-Flash Hazard

How do we calculate IE?

Tables

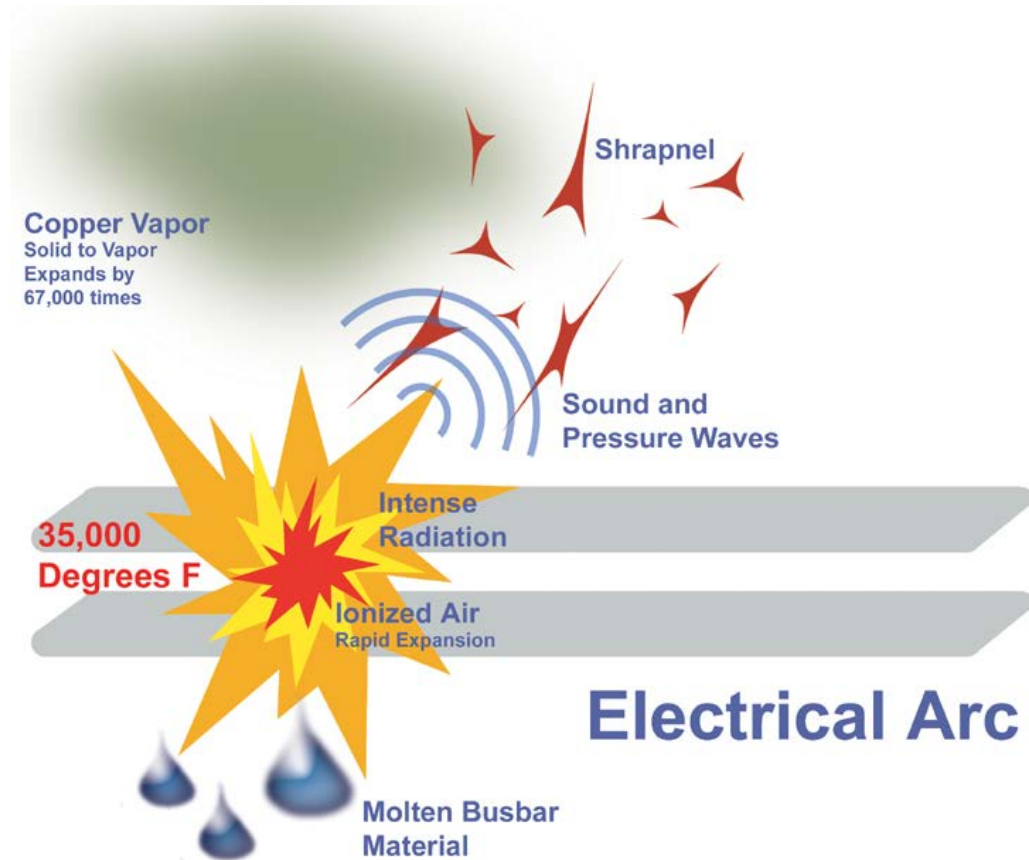


Analysis

 WARNING		
Arc Flash and Shock Hazard Appropriate PPE Required		
Arc Flash Hazard Boundary	5 ft 5 in	Incident Energy in cal/cm ² 9.8 PPE Requirements Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit
Working Distance	1 ft 6 in	
Shock Hazard Exposure	480 VAC	
Glove Class	00	
Limited Approach	3 ft 6 in	
Restricted Approach	1 ft	
Equipment ID:	ATS-CH1	Date: 10/03/14
<small>Hood-Patterson & Dewar, Inc</small>		<small>850 Center Way Norcross, Georgia 30071</small>

Arc Temperature

- Electric arcs produce some of the highest temperatures known to occur on earth
 - Up to 35,000°F
 - 4X temp of the SUN
 - Texas in August: 314 K (105°F)
- All known materials are vaporized at this temperature
 - Copper boils at 4650°F (2565°C)



Arc Flash/Blast

Other Hazards

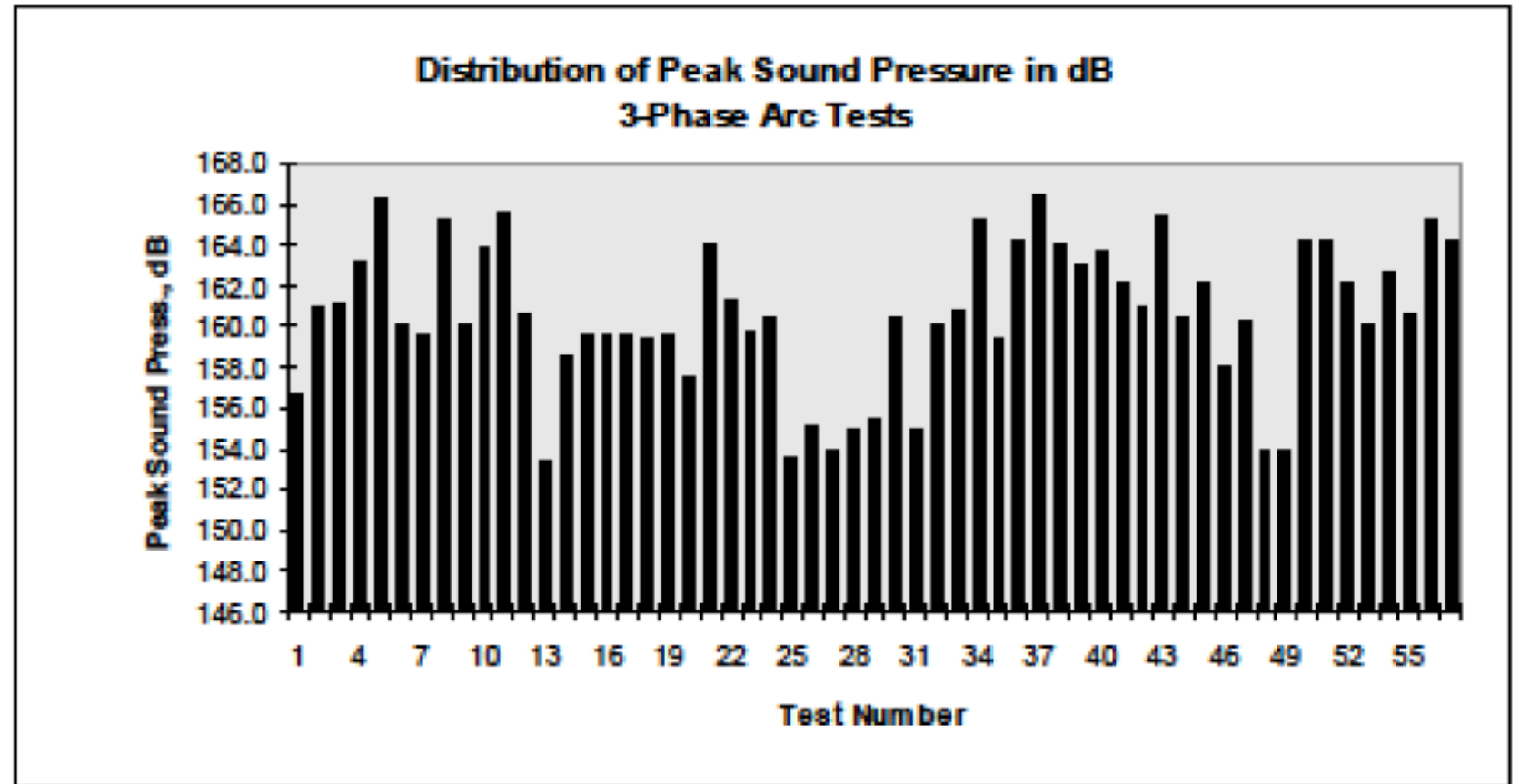
- Blast Pressure
 - High pressures of 1000's lb/ft²
- Light
 - Bright summer day is 100,000 lux (light intensity)
 - 1 lux= 1 lumen per square metre squared
 - Tens of millions of lux have been measured during arc flash testing
- Shrapnel
 - Can be expelled at 700m/hr



OSHA- Impact noise should not exceed 140dB Peak

Hearing Protection

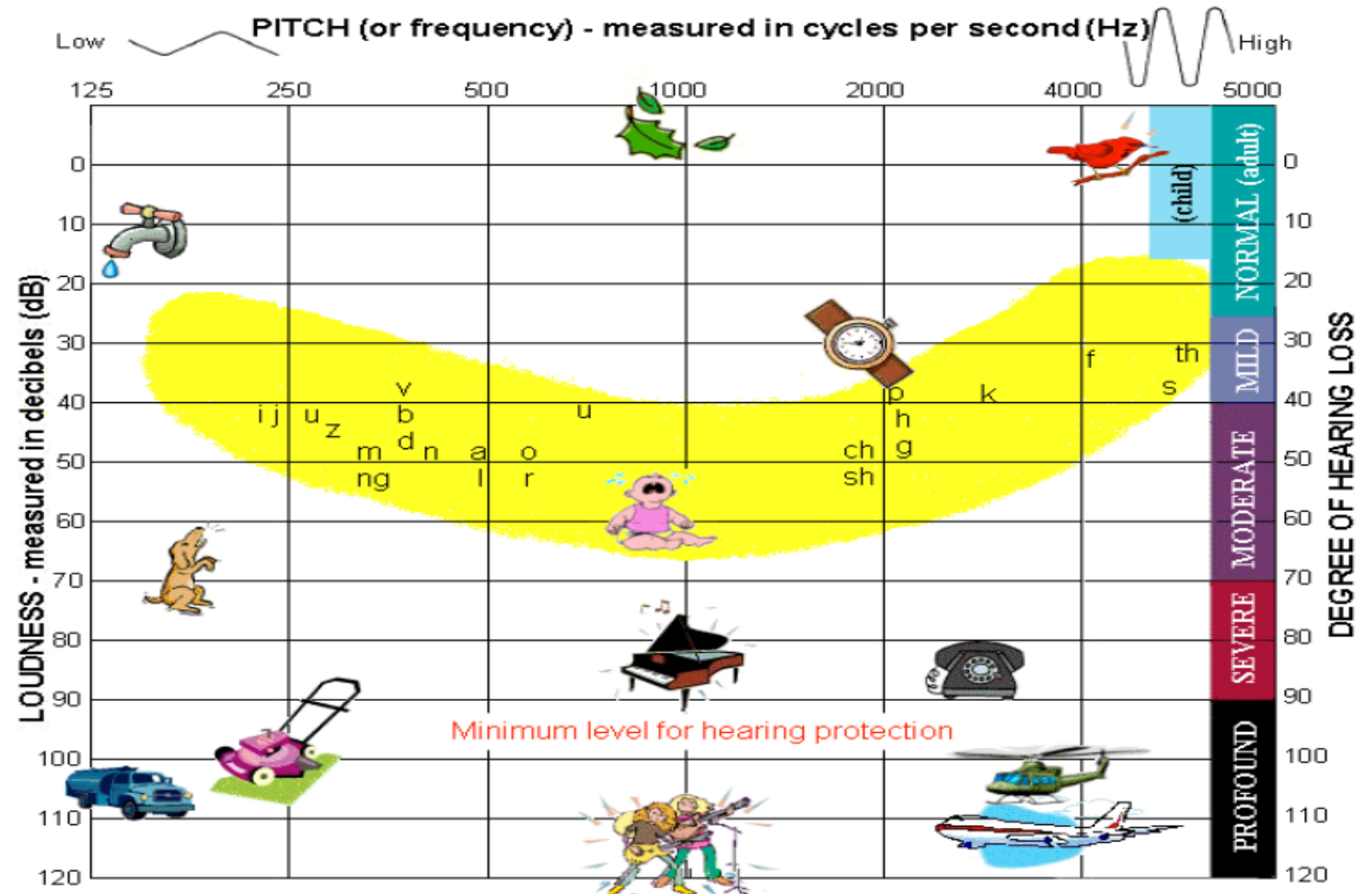
Low Voltage Arc Flash Tests



ESW 2015-07 – Hearing Protection-The Electrical Hazard you Don't hear about!

Hearing Protection

Since sensorineural hearing loss typically damages the cochlea, higher frequencies are more difficult to hear, especially the common consonants “S”, “F”, “TH”, and “H” and the inability to hear them can make conversations incredibly difficult.



OSHA Standard Noise Limits

ARE YOU AT RISK?

If you're exposed to sounds above 85 dB, you may be putting your hearing at risk.

140 DB

Gunshot, Jet Engine at Takeoff

IMMEDIATE DANGER TO HEARING

125 DB

Air Raid Siren, Firecracker

PAIN THRESHOLD

120 DB

Rock Concert, Sandblasting

RISK OF HEARING DAMAGE IN 7 MINUTES

115 DB

Baby's Cry, Jet Ski

RISK OF HEARING DAMAGE IN 15 MINUTES

110 DB

Snowmobile in Driver's Seat

RISK OF HEARING DAMAGE IN 30 MINUTES

105 DB

Jackhammer, Helicopter

RISK OF HEARING DAMAGE IN 1 HOUR

100 DB

Chain Saw, Stereo Headphones

RISK OF HEARING DAMAGE IN 2 HOURS

95 DB

Motorcycle, Power Saw

RISK OF HEARING DAMAGE IN 4 HOURS

90 DB

Lawnmower, Truck Traffic

RISK OF HEARING DAMAGE IN 8 HOURS

85 DB

Beginning of OSHA Regulations

70 DB

Busy traffic, Vacuum Cleaner

60 DB

Conversation, Dishwasher

40 DB

Quiet Room

Hearing Protection

A good rule to remember:

If you are 2-3 feet, or about an arm's length, from someone and you have to raise your voice for them to hear you over the noise in the area, you probably need hearing protection.



"If I was wearing my WHAT?!"

How To Put In Ear Plugs

Figure 1



1. Roll

the earplug up into a small, thin "snake" with your fingers. You can use one or both hands.



2. Pull

the top of your ear up and back with your opposite hand to straighten out your ear canal. The rolled-up earplug should slide right in.



3. Hold

the earplug in with your finger. Count to 20 or 30 out loud while waiting for the plug to expand and fill the ear canal. Your voice will sound muffled when the plug has made a good seal.

Check the fit when you're all done. Most of the foam body of the earplug should be within the ear canal. Try cupping your hands tightly over your ears. If sounds are much more muffled with your hands in place, the earplug may not be sealing properly. Take the earplug out and try again. (Source: NIOSH)

Arc-Flash Hazard

What Is It and
What Does It
Mean to Me?

“A source of possible injury or damage to health associated with the possible release of energy caused by an electrical arc”

- Acceptable damage (2nd degree burn) described as “reduced and survivable” with damage to head and torso...



Osha.gov

Ejected Arc



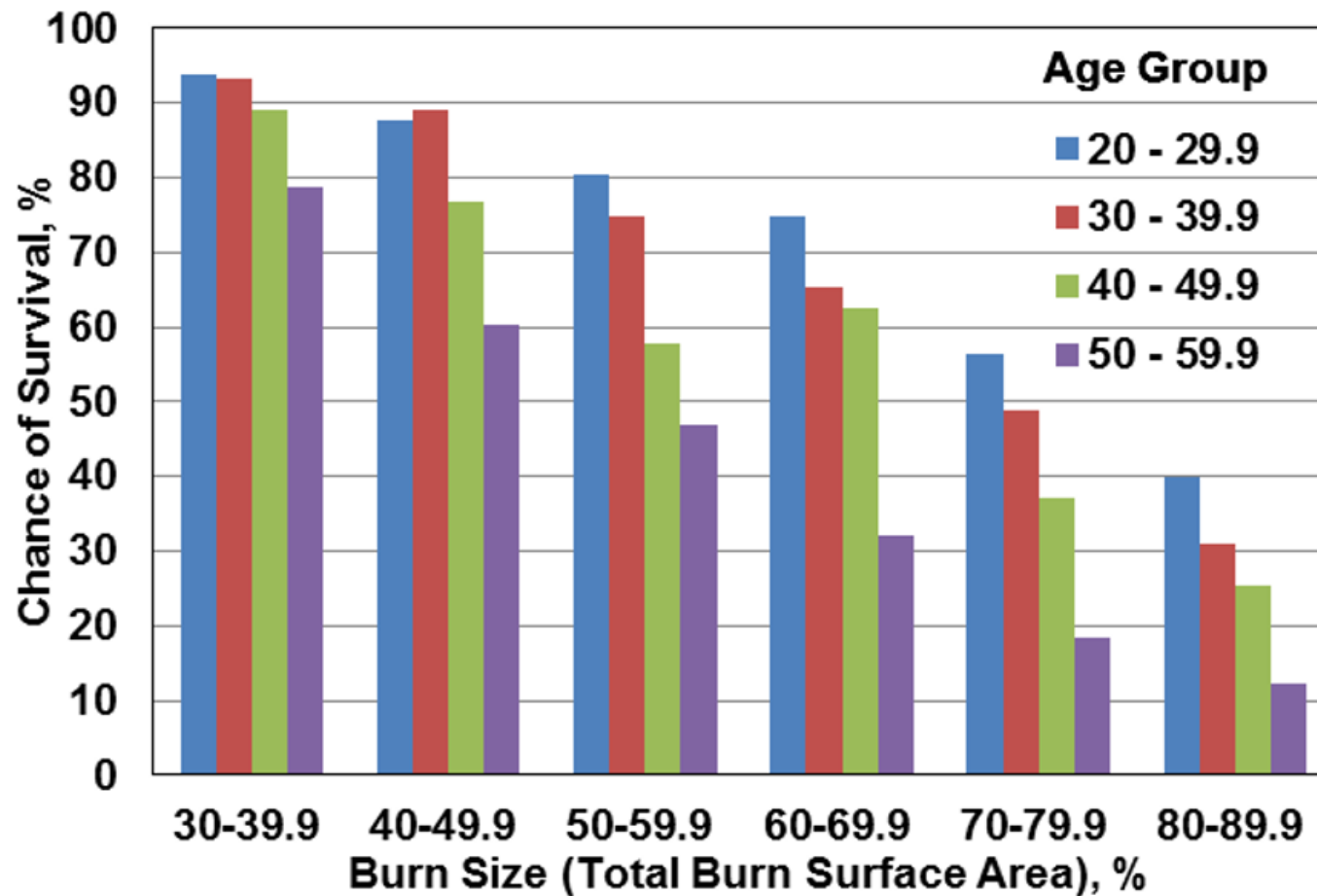
Arc Flash

Can Kill You at 10
feet

- 99 injuries involving electrical arcs / 21 fatalities
 - 75% reported 3rd degree burns



Burn Survival - Age and Body % Burned



Arcs Travel Through the Body

Electricity arcs through the air and entered his body. The current was drawn to his armpits because perspiration is very conductive.



This foot suffered massive internal injuries, which weren't readily visible, and had to be amputated a few days later.



Causes of Arcing Faults

- Inadvertent Contact
 - Misplaced tools
 - Voltage testers
- Insulation tracking, failure (moisture?)
- Rodents, vermin
- Unsuccessful S/C interruptions
- Voltage transients



Causes of Arcing Faults

Rodents, vermin



Causes of Arcing Faults

- Human error & mistakes
 - Common during maintenance
 - Mishandling a tool, wire, metal cover, etc.
- Failure to conduct preventive maintenance
 - Check for loose wiring & improperly torqued electrical terminations
 - Clean and inspect electrical equipment
 - Periodically test and operate moving parts designed to clear electrical faults
 - Adhere to NFPA 70-B Annex 1 defined maintenance intervals
 - Legacy equipment

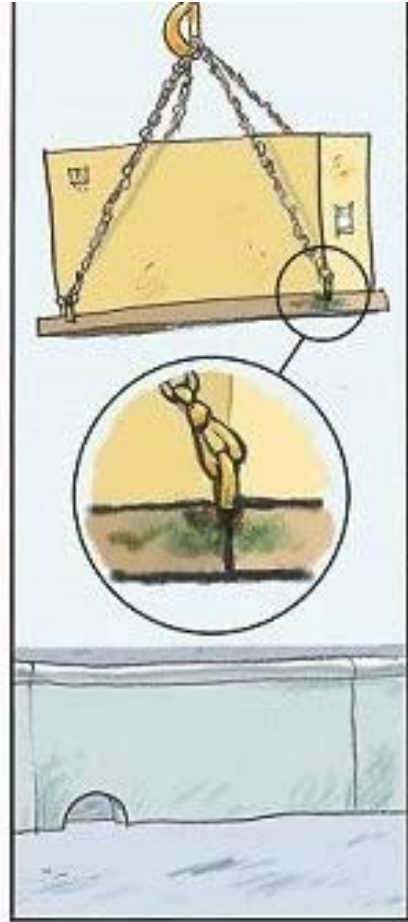
Causes of Arcing Faults

Human Error

70E 110.1 ESP

- Human Error – Potential for human error and its negative consequences on people, process, the work environment, and equipment.
 - Studies show that human error is the root cause of many incidents
 - 80% is unsafe act
 - Take short cuts
 - Accept unsafe work practices
 - 20% is unsafe condition
 - People are fallible, and even the best people make mistakes
 - Job planning, job briefing, hierarchy of controls can help reduce human error

Near Misses and Safety Opportunities



Unsafe Condition

**What could
possibly go
wrong?**



Causes of Arcing Faults

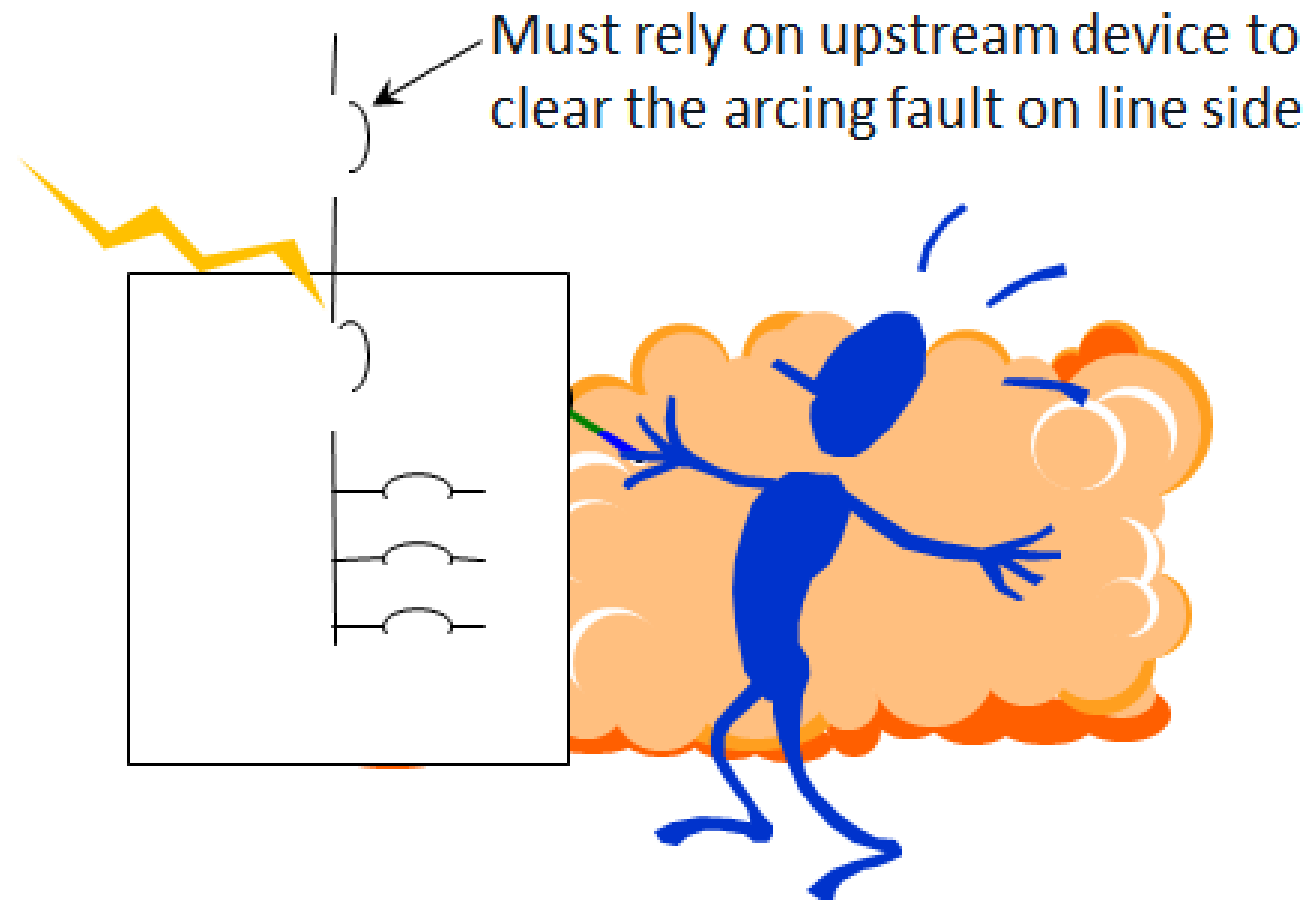
Human Error

The Human Factor

- Real time/Unexpected changes
- Off work plans
- What happened the night before
- Condition of workers
- Time pressures
- Concerns not expressed



Which device clears the arcing fault?



Arc-Flash Studies - FAQ

Why are these labels different?



Don't judge a book by its cover!

Arc-Flash Hazard

Where Does It Occur?

- Where in the electrical distribution system is this a concern?
 - NFPA 70E 2015 defines Arc-Flash Hazard by introducing the idea of **potential hazards when “interacting”** with the equipment in such a manor that could cause an electric arc
 - Is there an Arc Flash Hazard under **normal operating conditions?** Not likely

(NFPA-70E 130.7(A) Info Note No. 2)



Arc in a Box

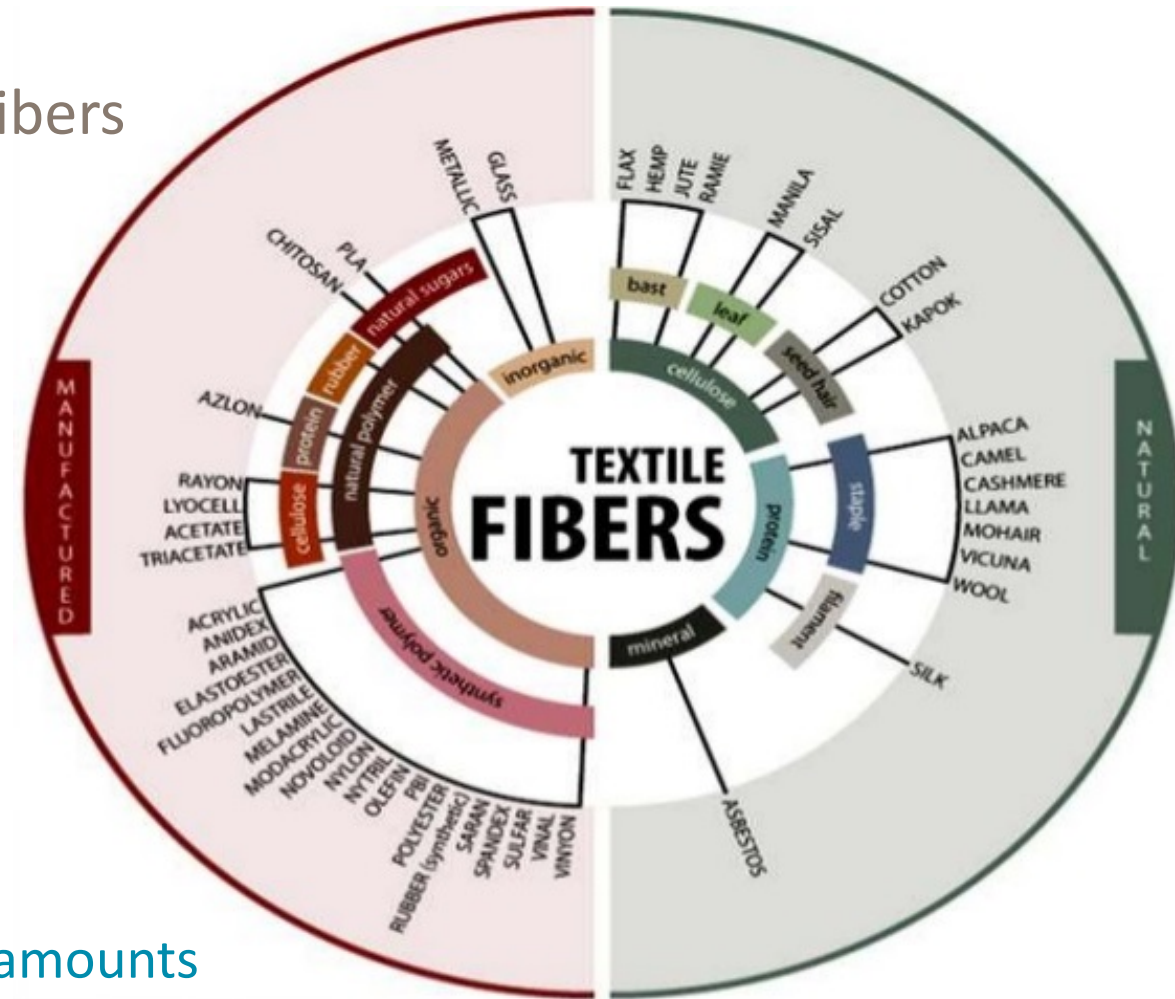
Arc-in-a-box energy can be two to twelve times greater when the arc is an *arc in open air*.



Rate 1100

What To and Not To Wear

- Anything touching your skin is considered “undergarments”
- Undergarments must be natural fibers
 - Cotton
 - Wool
 - Silk
 - Blends of these
- Not allowed
 - Nylon
 - Polyester
 - Rubber
 - Spandex
 - Exception: small amounts of these materials in waistbands or socks
 - Under Armor® or similar compression clothing is not allowed



NFPA 70E

Arc Rating (AR)

The value attributed to materials that **describes their performance to exposure to an electrical arc discharge**. The arc rating is expressed in cal/cm² and is derived from the determined value of the Arc Thermal Performance Value (**ATPV**) or the energy of break open threshold (**E_{BT}**). The arc rating is reported as either **ATPV** or **E_{BT}** whichever is the lower value.



“FR” Clothing

Very Generic

- Only has meaning in the framework of the hazard
- NFPA 701 is not allowed in garments; such use is a misuse of the standard, opening the company to liability when labeling garments as flame resistant per that standard since it is only for
 - Wall coverings
 - Curtains
 - Furnitureand other building uses, NOT clothing.
- Examples of FR Standards for its intended use
 - ASTM F1506, F1891 – Arc flash clothing
 - NFPA 2112 – Flash fire clothing
 - NFPA 1975 & 1971 – Structural firefighting clothing

“FR” melted on the head



Cotton vs. Cotton-Polyester Blend vs. Arc-Rated Clothing



NFPA 70E

ANNEX H: Simplified Two- Category Approach

Table H.2 Simplified Two-Category, Arc-Rated Clothing System

Clothing ^a	Applicable Tasks
Everyday Work Clothing Arc-rated long-sleeve shirt with arc-rated pants (minimum arc rating of 8) or Arc-rated coveralls (minimum arc rating of 8)	All arc flash PPE category 1 and arc flash PPE category 2 tasks listed in Table 130.7(C)(15)(A)(a), Table 130.7(C)(15)(A)(b), and Table 130.7(C)(15)(B) ^b
Arc Flash Suit A total clothing system consisting of arc-rated shirt and pants and/or arc-rated coveralls and/or arc flash coat and pants (clothing system minimum arc rating of 40)	All arc flash PPE category 3 and arc flash PPE category 4 tasks listed in Table 130.7(C)(15)(A)(a), Table 130.7(C)(15)(A)(b), and Table 130.7(C)(15)(B) ^b

^aNote that other PPE listed in Table 130.7(C)(16), which include arc-rated face shields or arc flash suit hoods, arc-rated hard hat liners, safety glasses or safety goggles, hard hats, hearing protection, heavy-duty leather gloves, rubber insulating gloves, and leather protectors, could be required. The arc rating for a garment is expressed in cal/cm².

^bThe estimated available short-circuit current capacities and fault clearing times or arcing durations are listed in the text of Table 130.7(C)(15)(A)(b) and Table 130.7(C)(15)(B). Various tasks are listed in Table 130.7(C)(15)(A)(a). For tasks not listed or for power systems with greater than the estimated available short-circuit capacity or with longer than the assumed fault clearing times or arcing durations, an arc flash risk assessment is required in accordance with 130.5.

Tables H.3(a) and (b) were revised by a tentative interim amendment (TIA). See page 1.

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Voltage Rated Gloves

Rubber Gloves go on first
then the Leather Gloves over the Rubber Gloves



You must have them tested every six (6)
months!

Voltage Rated Tools



TK60

**Wear PPE
Correctly OR
wear Correct
PPE**



Damaged PPE



CHANGES IN NFPA-70E 2018



NFPA 70E

History

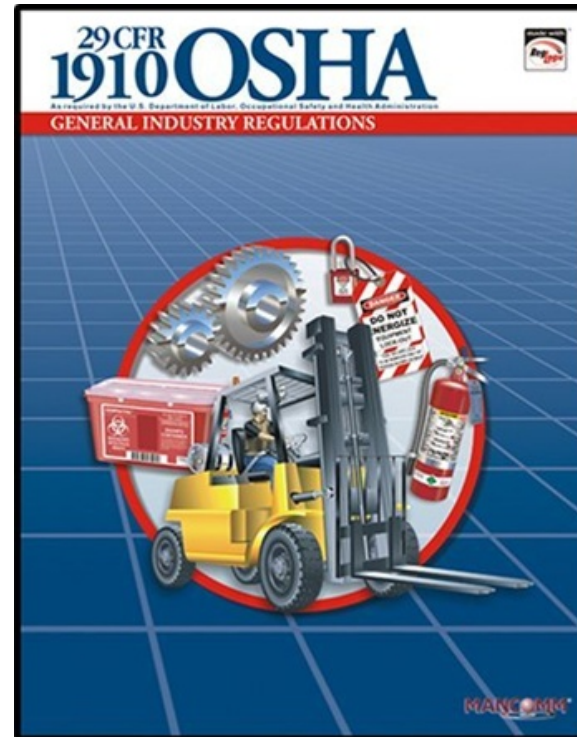


- Tenth Edition 2015
 - Emphasis on risk
 - From arc flash hazard analysis to arc flash risk assessment
 - Prohibited approach deleted
 - Category 0 removed from PPE table
 - Electrical Safety Program to include maintenance conditions
 - Arc flash label to include IE or table category BUT NOT BOTH
- Eleventh Edition 2018
 - Job Planning
 - Aligned LOTO with OSHA 1910.147
 - Introduces the human factor
 - Human error
 - Hierarchy of risk controls
 - **Removal 40cal/cm² reference**

OSHA 29 CFR 1910

Did you know??

- Became effective on January 2, 1990
 - Based on NFPA 70E-1988 (Rev 4)



Arc-Flash Hazard

When is This Going Down?

- We must Adhere to this NFPA-70E Now
 - We are NOT grandfathered in
 - NFPA-70E-2018 affective date of August 21, 2017 and supersedes all previous versions
- Latest version of NEC must be voted in before it takes effect

NFPA-70E 2018

Global Changes

- **New Terminology – Replaced**
 - “accident” with “incident”
 - “accidental” with “unintentional”
 - “accidentally” with “unintentionally”
 - “short circuit current” with “available fault current”

- **Reduced DC threshold from 100vdc to 50vdc**
 - Aligns with OSHA CFR 1910.303 – 50vdc
 - NFPA 70E Table 130.4(D)(b)- DC shock boundaries

70E – 105.3

Responsibilities

A. Employer Responsibility

1. Establish, document, and implement practices and procedures
 - MOPs, SOPs, PPE, etc
2. Provided employees with training in practices and procedures
 - On-the-Job, Classroom

B. Employee Responsibility


- Shall comply with the practices and procedures provided by the employer



The Arc-Flash Hazard Warning Label

130.5 (D) Equipment Labeling

- Electrical equipment such as **switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers** that are in other than dwelling units, and are likely to require **examination, adjustment, servicing, or maintenance** while energized, shall be field marked.

 WARNING		
Arc Flash and Shock Hazard Appropriate PPE Required		
Arc Flash Hazard Boundary	5 ft 5 in	Incident Energy in cal/cm ² 9.8 PPE Requirements Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit
Working Distance	1 ft 6 in	
Shock Hazard Exposure	480 VAC	Equipment ID: ATS-CH1 Date: 10/03/14
Glove Class	00	
Limited Approach	3 ft 6 in	
Restricted Approach	1 ft	
<small>Hood-Patterson & Davis, Inc. 857 Center Way Norcross, Georgia 30071</small>		

The Arc-Flash Hazard Warning Label

130.5 (D) Equipment Labeling


- Electrical equipmentwhile energized, shall be field marked with a label containing the following:
 - Nominal system voltage
 - Arc flash boundary
 - At least one of the following:
 - Available incident energy (IE) and the corresponding working distance, OR the arc flash PPE category in Table 130.7(C)(15)(A)(b) or Table 130.7(C)(15)(A)(b) but not both
 - Minimum arc rating of clothing
 - Site-specific level of PPE

Arc Flash Hazard Warning Label

Label Info

Incident Energy (IE)
based at defined distance

Distance for 2nd degree burn
Based on PNL
Voltage at Equipment
Glove Class based on Voltage
Shock Hazard
Voltage Based Distances
Equipment of interest

 WARNING													
Arc Flash and Shock Hazard Appropriate PPE Required													
<table border="1" style="width: 100%;"> <tr> <td>Arc Flash Hazard Boundary</td> <td style="text-align: right;">5 ft 5 in</td> </tr> <tr> <td>Working Distance</td> <td style="text-align: right;">1 ft 6 in</td> </tr> <tr> <td>Shock Hazard Exposure</td> <td style="text-align: right;">480 VAC</td> </tr> <tr> <td>Glove Class</td> <td style="text-align: right;">00</td> </tr> <tr> <td>Limited Approach</td> <td style="text-align: right;">3 ft 6 in</td> </tr> <tr> <td>Restricted Approach</td> <td style="text-align: right;">1 ft</td> </tr> </table>	Arc Flash Hazard Boundary	5 ft 5 in	Working Distance	1 ft 6 in	Shock Hazard Exposure	480 VAC	Glove Class	00	Limited Approach	3 ft 6 in	Restricted Approach	1 ft	<p>Incident Energy in cal/cm²</p> <h1 style="font-size: 2em;">9.8</h1> <p>PPE Requirements Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit</p>
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<small>Hood-Patterson & Dewar, Inc</small> <small>850 Center Way Norcross, Georgia 30071</small>													

* I.E. = Incident Energy
Article 100-Definitions

The Arc-Flash Hazard Warning Label

The Final Product...



Arc Flash and Shock Hazard

Appropriate PPE Required

89 inch	Flash Hazard Boundary
16.4	cal/cm² Flash Hazard at 18 inches
Class 3	Cotton Underwear + FR Shirt & Pant + FR Coverall
480 VAC	Shock Hazard when cover is removed
00	Glove Class
42 inch	Limited Approach (Fixed Circuit)
12 inch	Restricted Approach
1 inch	Prohibited Approach

Bus: C-H Prot: MCB C-H



Arc Flash and Shock Hazard

Appropriate PPE Required


Arc Flash Hazard Boundary	5 ft 5 in	Incident Energy in cal/cm ²
Working Distance	1 ft 6 in	
Shock Hazard Exposure	480 VAC	9.8
Glove Class	00	
Limited Approach	3 ft 6 in	
Restricted Approach	1 ft	
		PPE Requirements
		Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit


Equipment ID: **ATS-CH1**

Date: **10/03/14**

The Arc-Flash Hazard Warning Label

The Final Product...


 WARNING													
Arc Flash and Shock Hazard Appropriate PPE Required													
<table border="1" style="width: 100%;"> <tr> <td>Arc Flash Hazard Boundary</td> <td style="text-align: right;">5 ft 5 in</td> </tr> <tr> <td>Working Distance</td> <td style="text-align: right;">1 ft 6 in</td> </tr> <tr> <td>Shock Hazard Exposure</td> <td style="text-align: right;">480 VAC</td> </tr> <tr> <td>Glove Class</td> <td style="text-align: right;">00</td> </tr> <tr> <td>Limited Approach</td> <td style="text-align: right;">3 ft 6 in</td> </tr> <tr> <td>Restricted Approach</td> <td style="text-align: right;">1 ft</td> </tr> </table>	Arc Flash Hazard Boundary	5 ft 5 in	Working Distance	1 ft 6 in	Shock Hazard Exposure	480 VAC	Glove Class	00	Limited Approach	3 ft 6 in	Restricted Approach	1 ft	<p>Incident Energy in cal/cm²</p> <h1 style="font-size: 2em;">9.8</h1> <p>PPE Requirements Arc-rated shirt & pants + arc-rated coverall + arc-rated arc flash suit</p>
Arc Flash Hazard Boundary	5 ft 5 in												
Working Distance	1 ft 6 in												
Shock Hazard Exposure	480 VAC												
Glove Class	00												
Limited Approach	3 ft 6 in												
Restricted Approach	1 ft												
Equipment ID: ATS-CH1													
<i>Hood-Patterson & Dewar, Inc</i>													

 WARNING															
Arc Flash and Shock Hazard Appropriate PPE Required															
<table border="1" style="width: 100%;"> <tr> <td>Incident Energy in cal/cm²</td> <td style="text-align: right;">1.2</td> </tr> <tr> <td>Arc Flash Hazard Boundary</td> <td style="text-align: right;">1 ft 6 in</td> </tr> <tr> <td>Working Distance</td> <td style="text-align: right;">1 ft 6 in</td> </tr> <tr> <td>Shock Hazard Exposure</td> <td style="text-align: right;">208 VAC</td> </tr> <tr> <td>Glove Class</td> <td style="text-align: right;">00</td> </tr> <tr> <td>Limited Approach</td> <td style="text-align: right;">3 ft 6 in</td> </tr> <tr> <td>Restricted Approach</td> <td style="text-align: right;">Avoid Contact</td> </tr> </table>	Incident Energy in cal/cm ²	1.2	Arc Flash Hazard Boundary	1 ft 6 in	Working Distance	1 ft 6 in	Shock Hazard Exposure	208 VAC	Glove Class	00	Limited Approach	3 ft 6 in	Restricted Approach	Avoid Contact	<p>Hill Brands PPE Level</p> <h1 style="font-size: 3em;">1</h1> <p>PPE Requirements Natural Fiber Shirt, Pants, and Safety Glasses</p>
Incident Energy in cal/cm ²	1.2														
Arc Flash Hazard Boundary	1 ft 6 in														
Working Distance	1 ft 6 in														
Shock Hazard Exposure	208 VAC														
Glove Class	00														
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Equipment ID: PANEL A															
Date: 02/13/16															
<div style="display: flex; justify-content: space-between;"> Hood Patterson & Dewar hoodpd.com 850 Center Way, Norcross, GA 30071 </div>															

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Changes

- 40 cal/cm² Restriction Removed
- 130.7 (A) Informational Note 3 – removed from 2018 version
 - Used to warn that “greater emphasis may be necessary with respect to de-energizing” equipment that exceeds 40 cal/cm²

 DANGER	
NO SAFE PPE EXISTS	
ENERGIZED WORK PROHIBITED	
153 in	Flash Risk Boundary
40 cal/cm²	Flash Risk at 18 in
PPE	DO NOT WORK ON LIVE!
480 VAC	Shock Risk when cover is removed
00	Glove Class
42 in	Limited Approach
12 in	Restricted Approach
N/A	Minimum Arc Rating
Location:	110GCBJ

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What is your
approach?

Your approach should be to exceed the code's expectations

- When safety is a priority, a greater emphasis should always be placed on de-energizing equipment $>1.2\text{cal/cm}^2$
- If live work over 40 cal/cm^2 is desired, equipment would need to be re-labeled

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Is it required that I
relabel my facility?

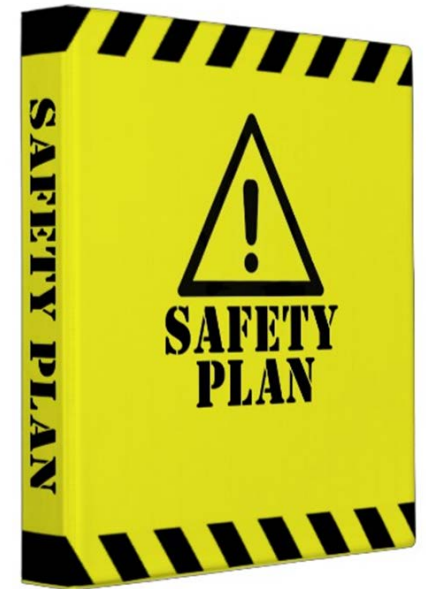
130.5(H) Exception 1

- *“.....Labels applied prior to the effective date of this edition (2018) shall be acceptable if they complied with the requirements for equipment labels in the standard in effect at the time the labels were applied.”*

NFPA 70E 2018

110.1 Electrical Safety Program (ESP)

- A. General
- B. Inspection**
- C. Condition of Maintenance
- D. Awareness and Self-Discipline
- E. Electrical Safety Program Principles
- F. Electrical Safety Program Controls
- G. Electrical Safety Program Procedures
- H. Risk Assessment Procedures
 - A. Human Error**
 - B. Hierarchy of Risk Control Methods**
- I. Job Safety Planning and Briefing**
- J. Incident Investigations *
- K. Auditing
 - A. LOTO Program and Procedure Audit**



Electrical Safety Program (ESP)

Risk Assessment Procedure

(Performed before work is started)

- Identify hazards
- Assess risks
- Implement risk control according to a hierarchy of methods



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Risk Assessment Terminology

- Hazard
 - Source of harm – injury, damage or death
- Risk
 - Combination of the likelihood of harm occurring and the severity of that harm
- Risk Assessment
 - A process of hazard identification, risk analysis and risk evaluation

NFPA 70E 2018 Example

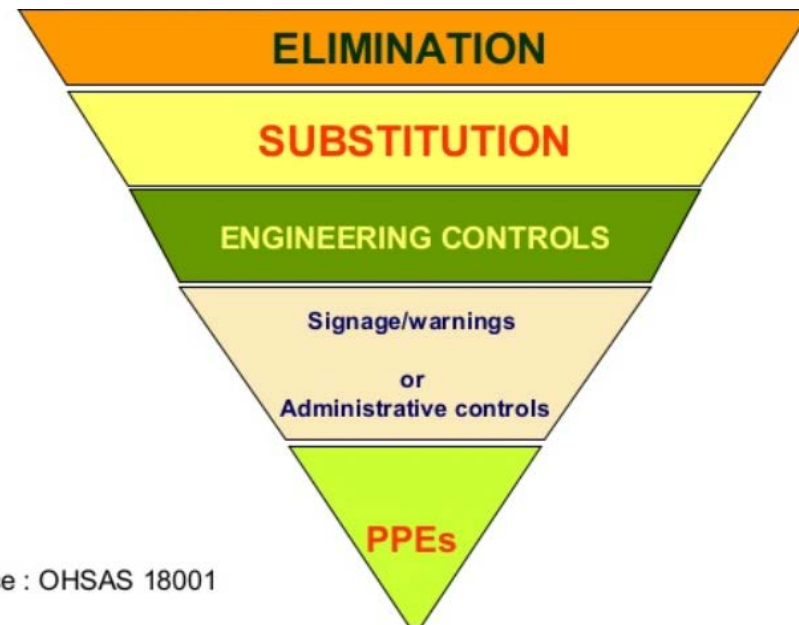
What is a Risk Assessment for Shock?

- Likelihood of making electrical contact
 - Is electrical contact possible when crossing the restricted approach?
 - Not: Can the worker be careful enough to avoid the electrical shock?
- Severity of harm
 - Could electrical contact result in harm (e.g. burns, loss of body parts, or death)?
 - Not: It's ok since I've been shocked before with no lasting effect

Hierarchy of Controls

From ANSI Z.10

1. Elimination-
 - Physically removing the hazard – **TURN IT OFF**
2. Substitution-
 - Replace with non-hazard equipment – **ARC-RESISTANT SWITCHGEAR**
3. Engineering controls-
 - Isolate workers from hazard – **REMOTE RACKING DEVICE**



Source : OHSAS 18001

Hierarchy of Controls

4. Warning/Awareness

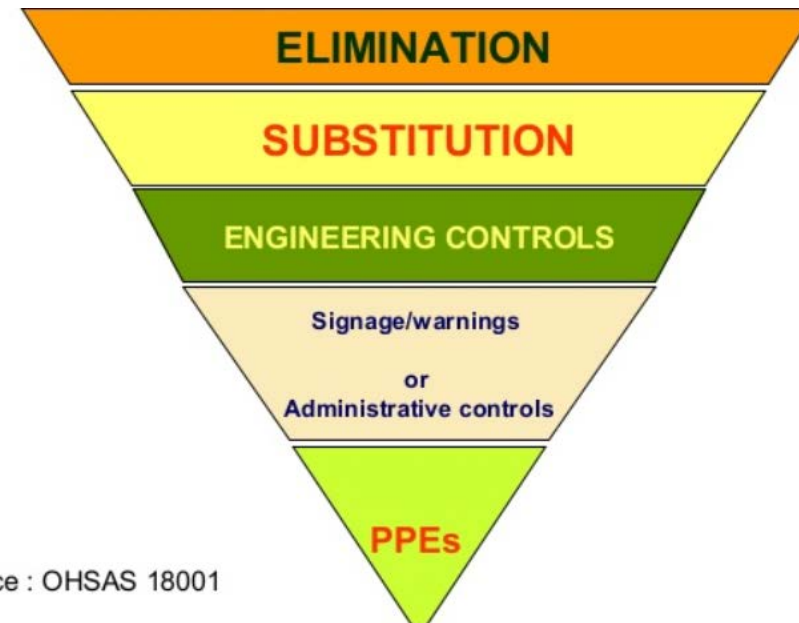
- Making workers aware of hazards and risks – **SIGNS, WARNING LIGHTS**

5. Administrative Controls

- Standardize the way to perform task – **DEVELOP POLICIES, TRAINING**

6. Personal Protective Equipment (PPE)

- Reduces the effects in attempt to make injury survivable – **AR CLOTHING, SAFETY GLASSES etc.**



Source : OHSAS 18001

Hierarchy of Controls

IV AWARENESS



**NOT ONLY WILL THIS
KILL YOU, IT WILL HURT
THE WHOLE TIME
YOU ARE DYING**

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Safety Planning

110.1(I)

I. Job Safety Planning and Job Briefing

1. Job Safety Planning

1. Be completed by a qualified person
2. Be documented
3. Include the following information
 - a) Job and task description
 - b) Identify hazards
 - c) Shock assessment
 - d) Arc flash assessment
 - e) Work procedures, special precautions, and energy source controls

2. Job Briefing – Shall cover the job safety plan

3. Change in Scope – Additional planning to occur if changes occur

Electrical Safety Program (ESP)

General,
Inspection, and
Condition of
Maintenance

- 110.1(B)-Condition of Maintenance
 - The ESP shall include elements that consider conditions of maintenance of electrical systems.
- 110.1(H)(2)-Human Error
 - The ESP shall address the potential for human error and its negative consequences....
- 110.1(J)-Incident Investigations
 - The ESP shall include elements to investigate electrical incidents

Damaged PPE



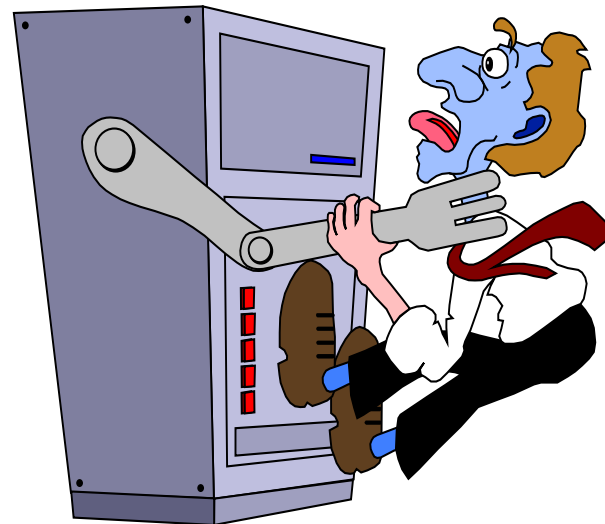
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Article 120:
Lockout/Tagout

OSHA 147

The “Fatal Five” Main Causes of Lockout/Tagout Injuries

- Failure to stop equipment
- Failure to disconnect from power source
- Failure to dissipate (bleed, neutralize) residual energy
- Accidental restarting of equipment
- Failure to clear work areas before restarting



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Article 120: Lockout/Tagout

- Additions to 120.5 (7) regarding “adequately rated” portable test instruments
 - **Exception 1** added to allow operators to use permanently installed meters rather than handheld meters to test conductors and circuit parts
 - **Exception 2** added to allow non-contact test instruments for electrical systems over 1000V



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110.2(A)(1)

Are you qualified?

- Qualified Person
 - A qualified person shall be trained and **knowledgeable in the construction and operation** of the equipment or a specific work method and be trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method.
 - 1) Distinguish exposed energized electrical conductors or circuit parts from other parts
 - 2) Determine nominal voltage
 - 3) Approach distances

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110.2(D) Employee Training

- (1) Qualified Person
 - (4)(e) An employee who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a qualified person, and who in the course of such training **demonstrates** an ability to perform specific duties safely at his or her level of training and who is under the direct supervision of a qualified person for the performance of those specific duties.

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110.2(D) Employee Training

- Article 100 definitions
 - Unqualified Person
 - A person who is not a qualified person 😊
- (2) Unqualified Persons
 - Unqualified persons shall be trained in, and be familiar with, any electrical safety-related practices necessary for their safety.

Lunch Time!!

