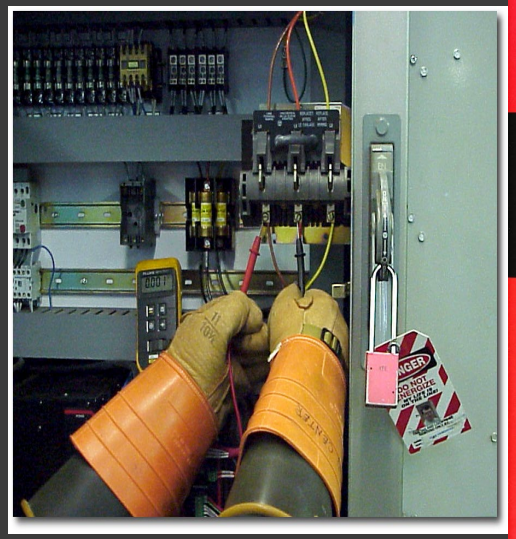
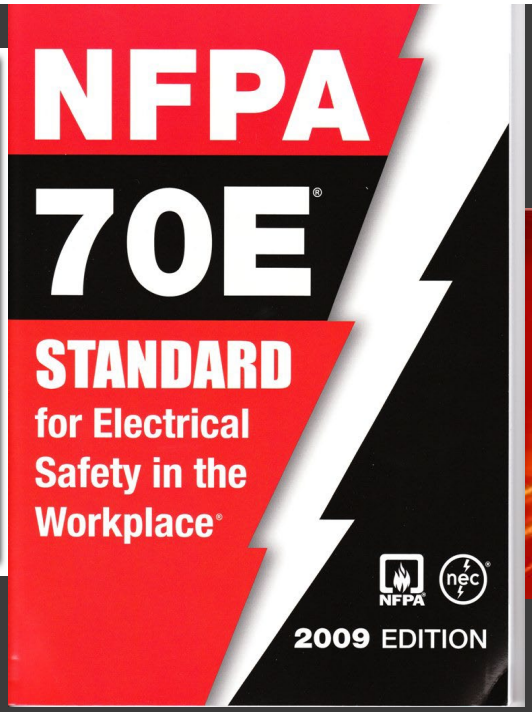
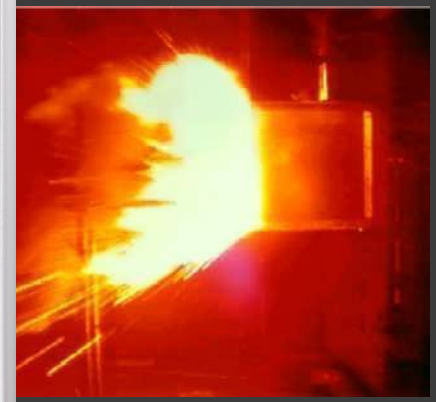
NCDOL
N.C. Department of Labor







NFPA 70E Electrical Safety, Arc Flash/Blast

LEARNING OBJECTIVES:

- *Why Electrical Safety and Arc Flash Protection?*
- *What is electrical safety?*
- *What does electrical safety consist of ?*
- *What does electrical safety look like?*
- *How does electrical safety apply to your workplace?*
- *Which standards apply to electrical safety?*
- *How to Recognize Electrical Hazards in the Workplace*

LEARNING OBJECTIVES:

- *How to Identify Electrical Hazards in the Workplace*
- *How to Establish an Electrical Safe Work Condition*
- *How to Evaluate Voltage & Arc Flash Hazard Potential - Tables vs. Calculation*
- *How to Properly Select & Use PPE*
- *How to Perform Work on or Near Energized Parts*
- *How to Cite Electrical Safety Following NFPA 70E and OSHA Electrical Standards*
- *How to Establish an Electrical Safety Program*
- *NFPA 70E 2012 – What's Coming*

Why Electrical Safety & Arc Flash Protection

What is Electrical Safety

What is Electrical Safety

- Protecting workers from the unexpected start-up, or unexpected reenergization of equipment, circuits, or parts while maintenance is being performed.
- Protecting workers from exposure to live electrical parts Including overhead and underground electrical distribution, including systems, equipment, circuits, and parts.

IT IS MANDATORY!

What is Electrical Safety?

- Documented Electrical Safe Work Practices Programs
- Selection, Use, Maintenance, Storage of Proper PPE
- Employee Training

Electrical Safe Work Practices

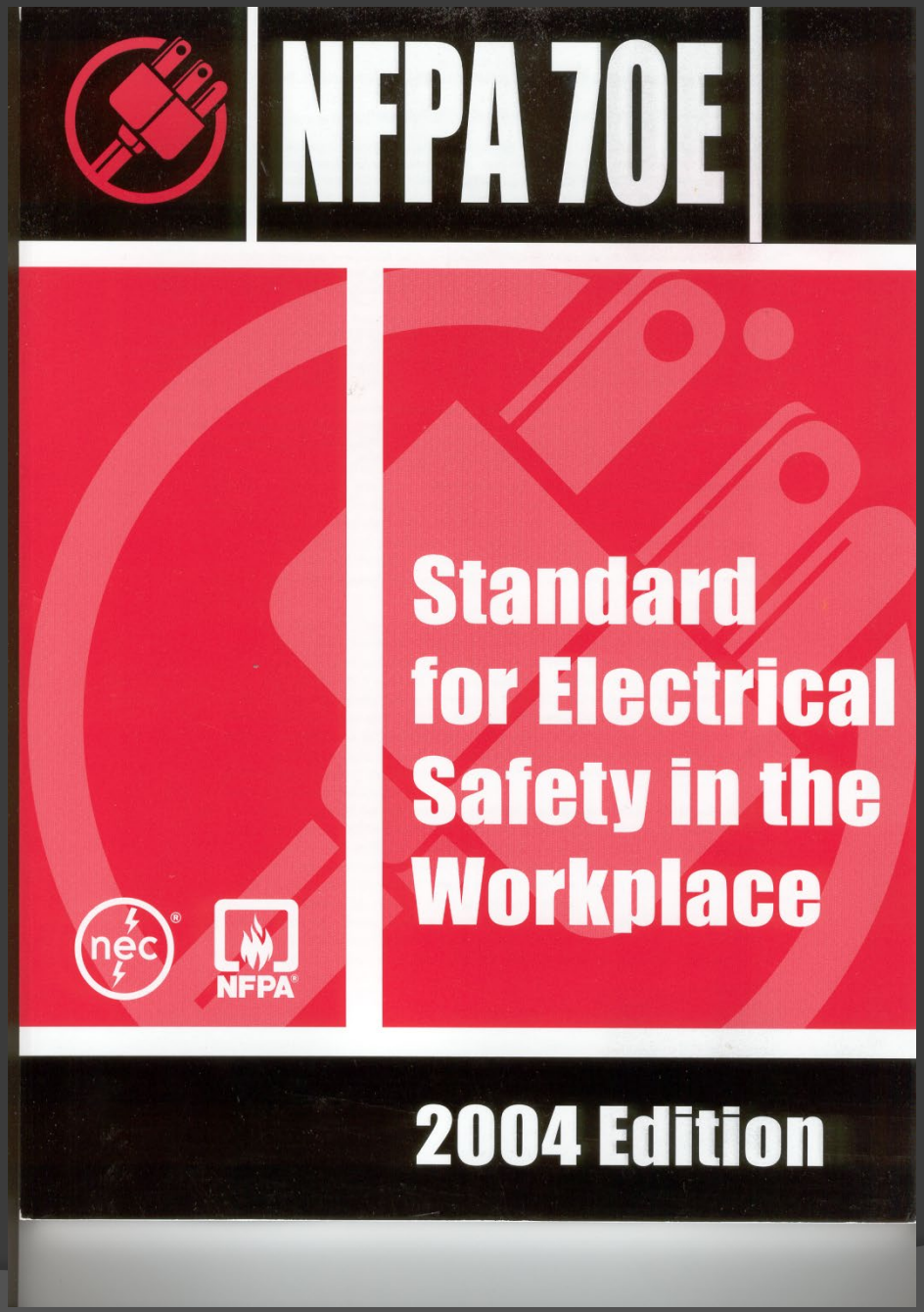
- Lockout Tagout
- Proper Tools & Equipment
- Energized Electrical Work Permit Procedures

Who's Responsible for Safety?

- **The "Employer" is responsible for**
  - OSHA requirements
  - Electrical Safety Program
  - Safety Policies and Procedures
  - Safety Training
- **The "Employee" is responsible for**
  - Implementing procedures
- **The "Owner" is inherently responsible for**
  - Contractors on site

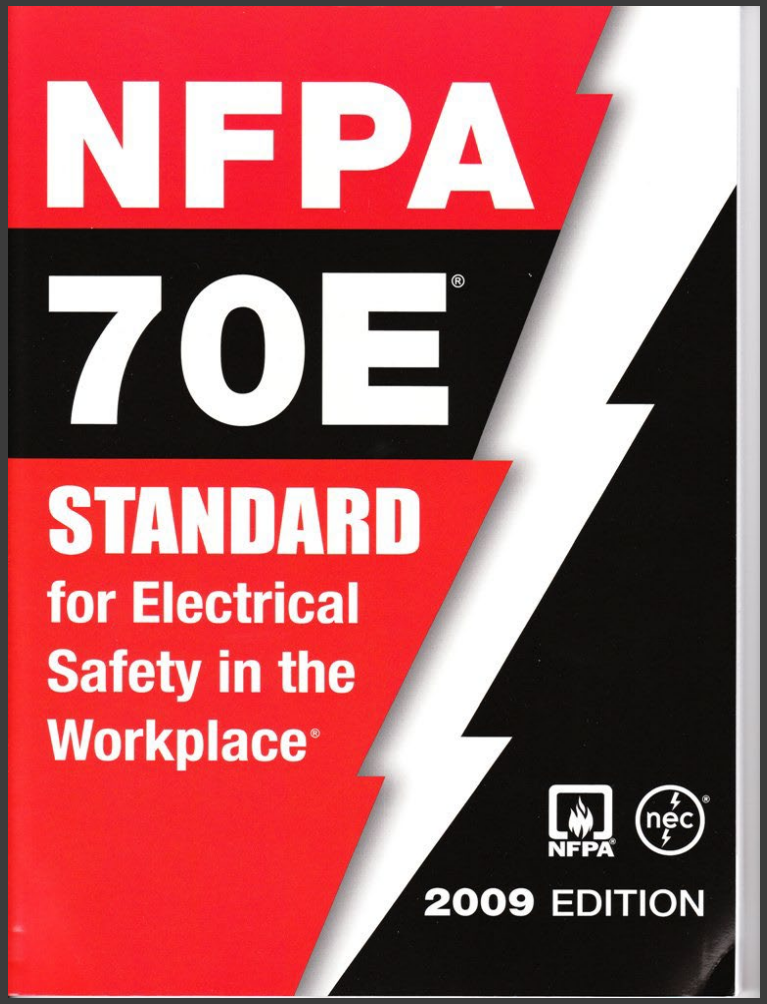
Which Standards Apply?

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


NFPA 70E
Standard for Electrical Safety in the Workplace
nec
NFPA
2004 Edition


70E
NFPA 70E
Standard for
Electrical Safety
Requirements for
Employee
Workplaces
2000 Edition

NFPA 70E – 2009 Edition



NFPA 70E Electrical PPE

- NFPA 70E, Section 130.7(A)

  Personal and Other Protective Equipment

  (A) General.

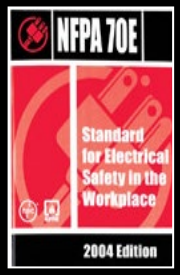
  (1) Employees working in areas where electrical hazards are present shall be provided with, and shall use, electrical protective equipment that is designed and constructed for the specific part of the body to be protected and for work to be performed.

OSHA Electrical PPE

- OSHA 1910.335 Safeguards for personnel.
- (a) Use of protective equipment
- Issue: When OSHA has an existing standard, OSHA cannot incorporate another standard by reference which addresses the same material. This is the case with 1910.335(a)(1).

Standards

US National Fire Protection Association
-Standard NFPA 70E



Canadian Standards Association
-Standard Z-462

CANADIAN STANDARDS ASSOCIATION

Canadian Electrical Code
-Rule 2-306

Electrical Safety Authority

Institute of Electrical & Electronics Engineers
-Standard 1584

IEEE

US Occupational Safety & Health Administration

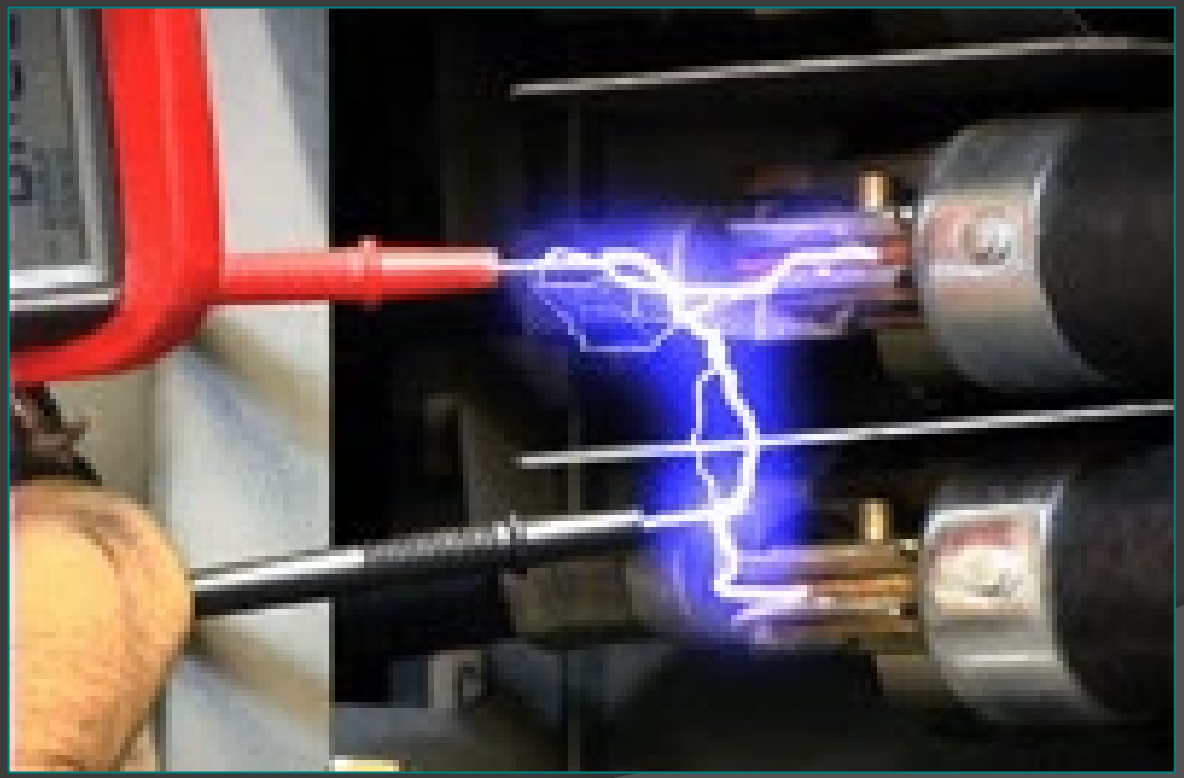
OSHA 1971 35 2006

Occupational Health & Safety Act
-Applicable regulations

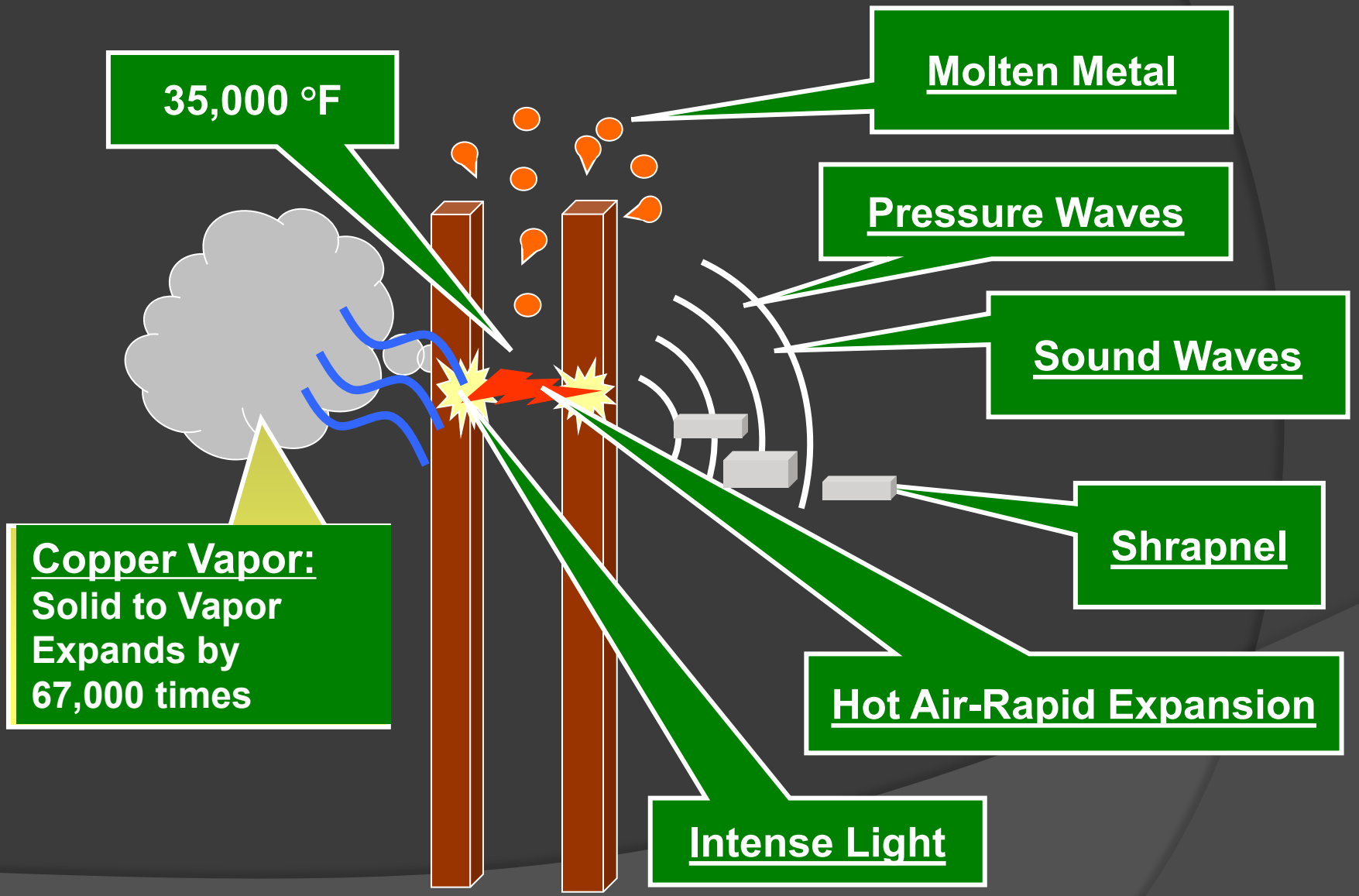
Arc Flash/Arc Flash/Shock Hazards

What is an Electric Arc?

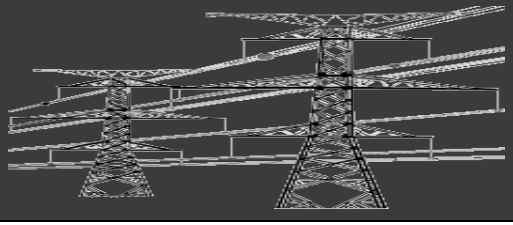
An electric arc is a short circuit through the air.



Electrical Arc



Electrical Arc Burn Hazards



Some Temperature & Heat Data	
Curable Burn Temperature (1/10th Sec.)	145ºF
Cell Death Temperature (1/10th Sec.)	205ºF
Temperature At Arc Terminals	35,000ºF
Temperature Of Sun’s Surface	9,000ºF
Temperature Of Burning Clothing	1,400ºF
Clothing Ignition Temperature	700ºF to 1,400ºF
Temperature Of Metal Droplets	1,800ºF

Characteristics of an Electric Arc

- An electric arc will oscillate and escalate if not constrained.
- A single-phase electric arc can engulf a second or third conductor in only two cycles.
- An electric arc’ s current propels the arc away from the power source.

Arc Flash

What Causes Arc Flash?

- Dust, impurities, corrosion, condensation, animals
- Spark discharge from:
  - Accidental touching
  - Dropping tools
- Over-voltages across narrow gaps
- Failure of insulating materials
- Equipment failure

Severity Factors

Power – amount of energy at the arc

Distance – of the worker to the arc

Time – duration of the arc exposure

Arc Flash Events

Electric arc → Arc flash → Arc blast

Compliments of Salisbury Electrical Safety L.L.C.

Forms of Arc Flash Energy

- Noise
- Expansion
- Vaporization
- Thermal radiation

Electrical Arc Burn Injuries

- Occur from high temperature sources
- Deep and slow to heal
- Involve large areas of body
- Distance from arc determines severity

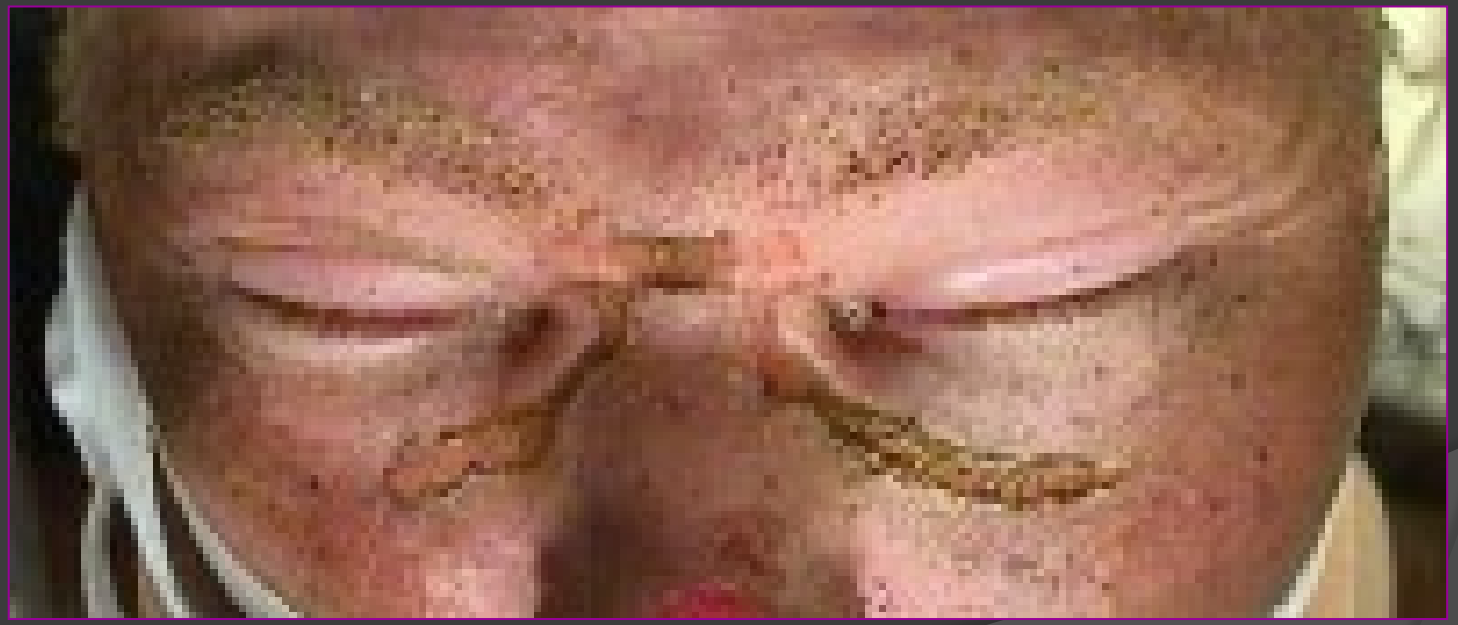
Electric Shock Injury – Burn

Severe Burns from Arc Flash

Arc flash	up to 35,000° F
Sun	9,900° F

Blindness

- Flash of light is so intense it can damage vision.



Shrapnel Wounds

Material and molten metal can hit the body at over 700 miles per hour.

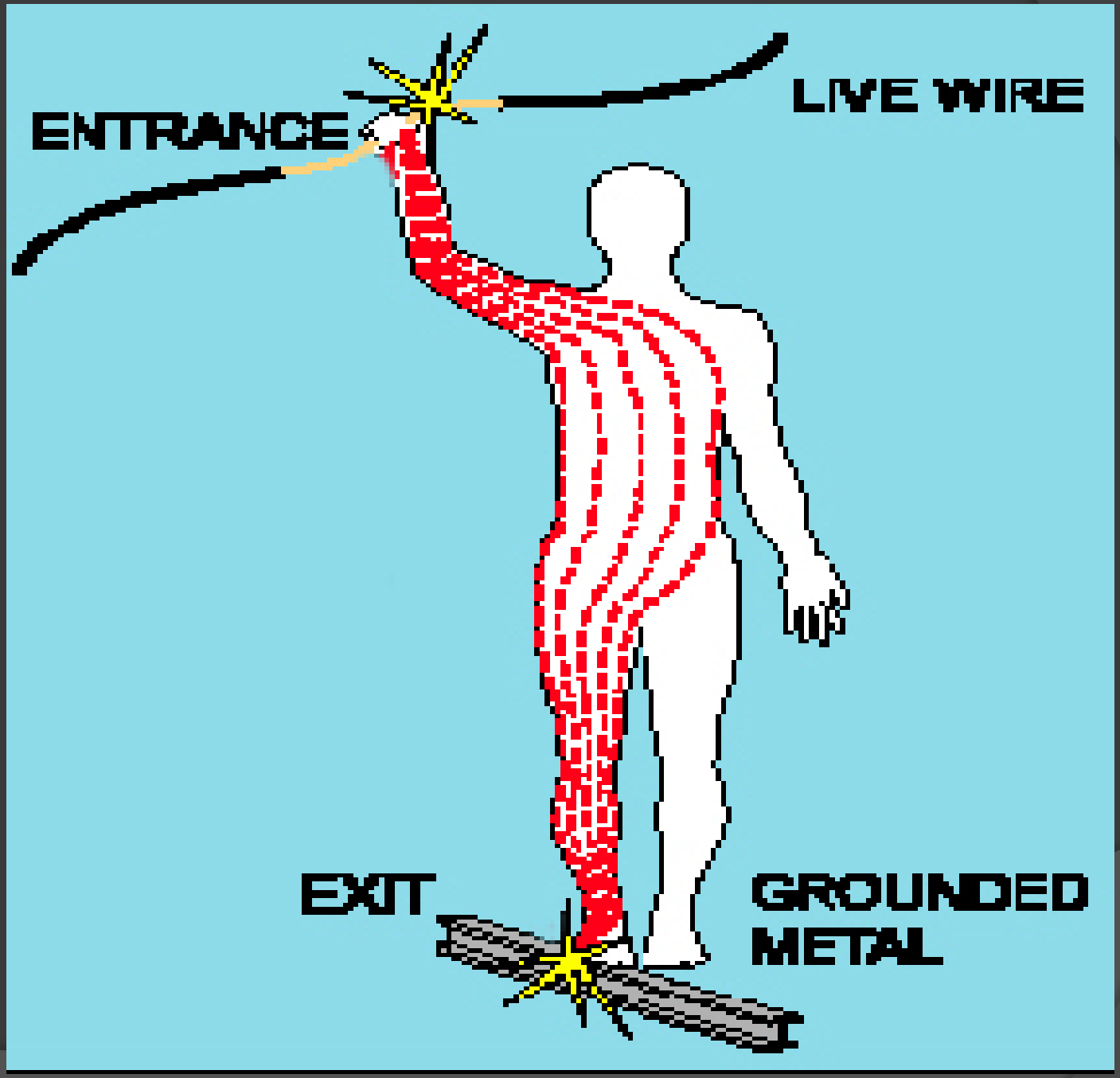
Blast Lung Injury (BLI)

- Arc blast can cause inhalation injuries.
  For example:
  - Inhaling high temperature copper vapor
  - More than 100 toxic substances can be found in the fumes.

BLI + Burns = Greater chance of death

Hearing Damage

Arc blast at 2 feet	145 decibels
Jet engine at 200 feet	132 decibels
Pain threshold	130 decibels


ENTRANCE
LIVE WIRE
EXIT
GROUNDED METAL

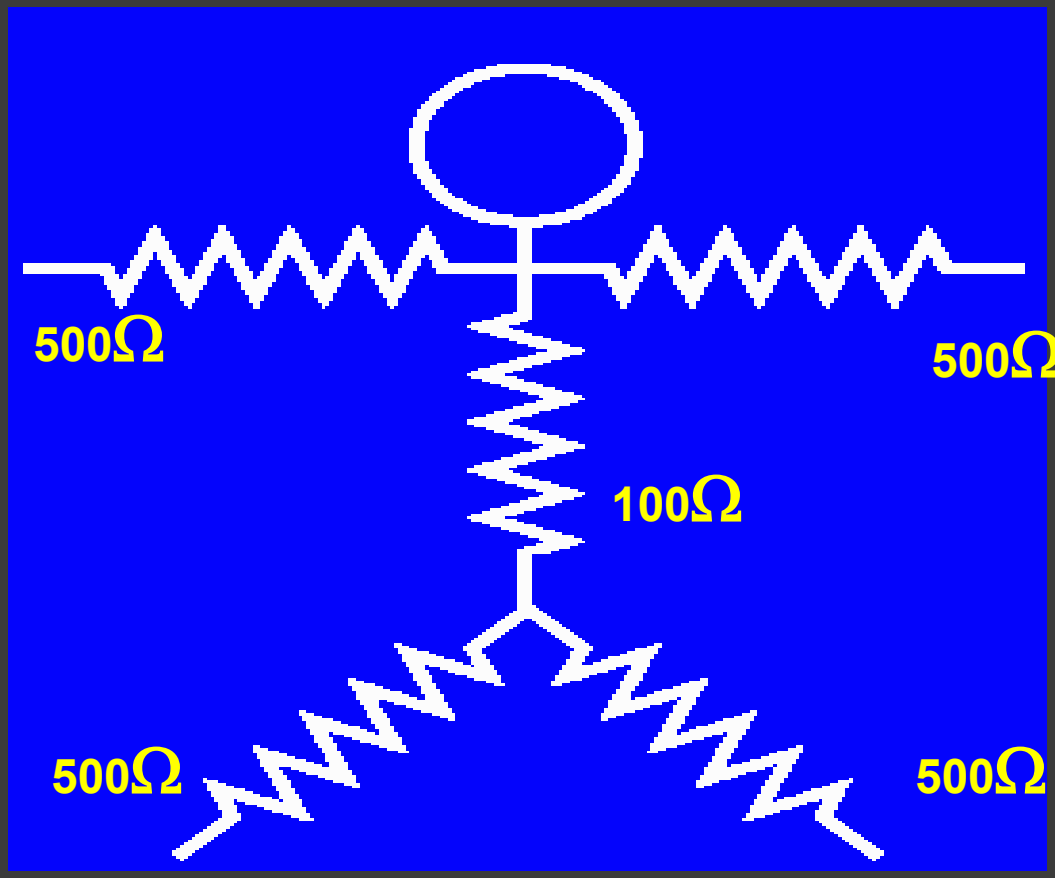
- Remember …
- It only takes 52-75 ma of current to cause the heart to go into fibrillation!

Shock

Current, Not Voltage causes Electric Shock

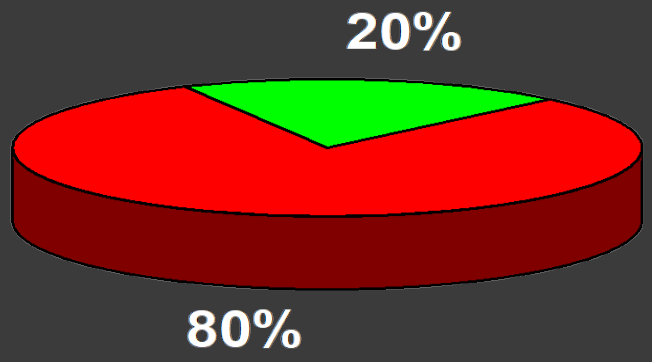
- **0.5 - 3 mA** - Tingling sensations
- **3 - 10 mA** - Muscle contractions and pain
- **10 - 40 mA** - "Let-go" threshold
- **30 - 75 mA** - Respiratory paralysis
- **100 - 200 mA** - Ventricular fibrillation
- **200 - 500 mA** - Heart clamps tight
- **1500 + mA** - Tissue and Organs start to burn

Note: Reaction will vary with frequency and time of exposure



- Hand to hand 1000Ω
- 120 volt
- Formula I = E/R
- 120/1000 = 0.120 amps or 120 ma

Inexperience = Accidents



- Employees Who Have Less Than 12 Months Experience at a Different or New Task, Account For 80% of ALL Accidents

Recognizing Electrical Hazards in the Workplace

What Voltages are Present?

120V
480V
4160V

What Voltages are Present?

- 7.2KV
- 13.8KV
- 14.4KV

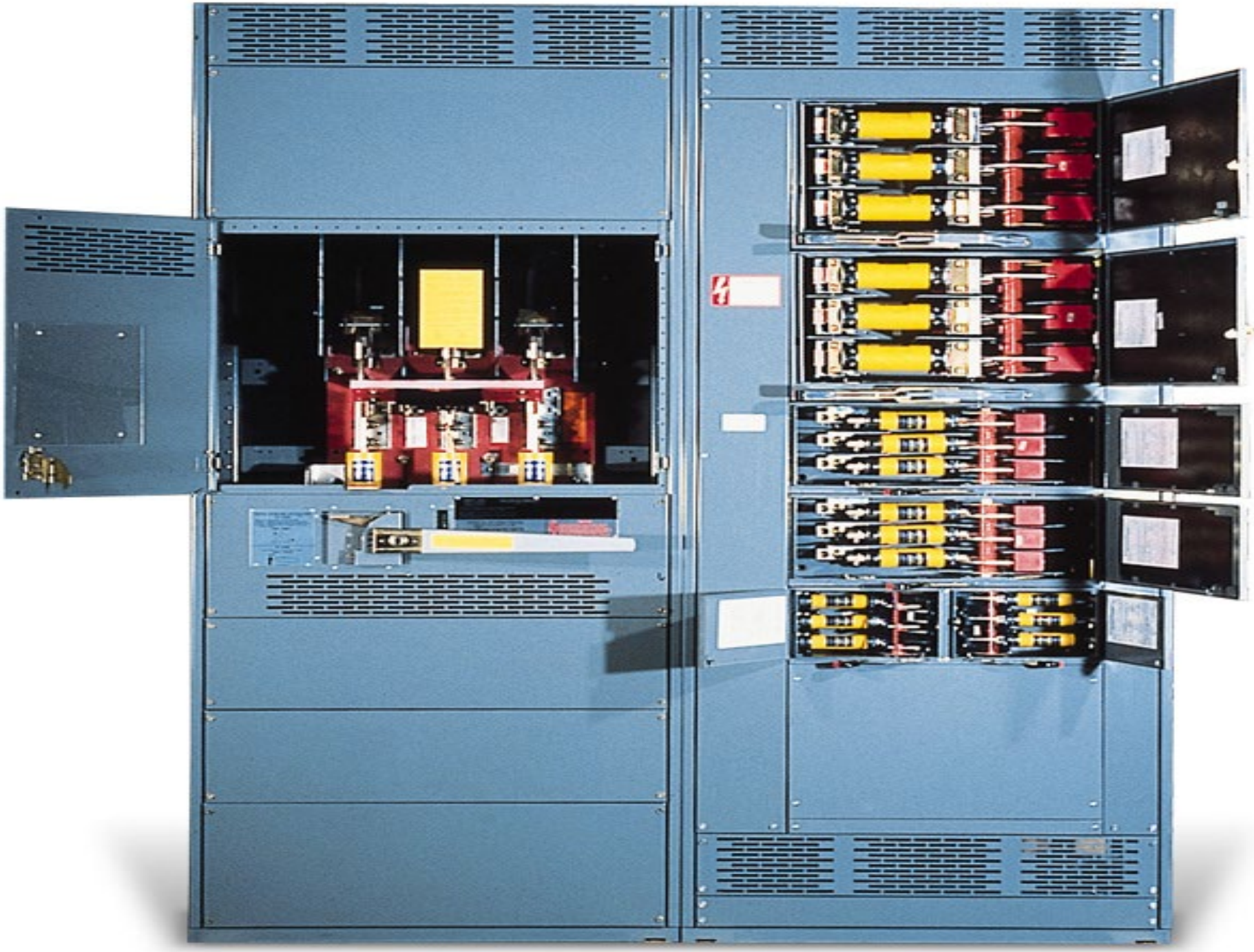
What Voltages are Present?

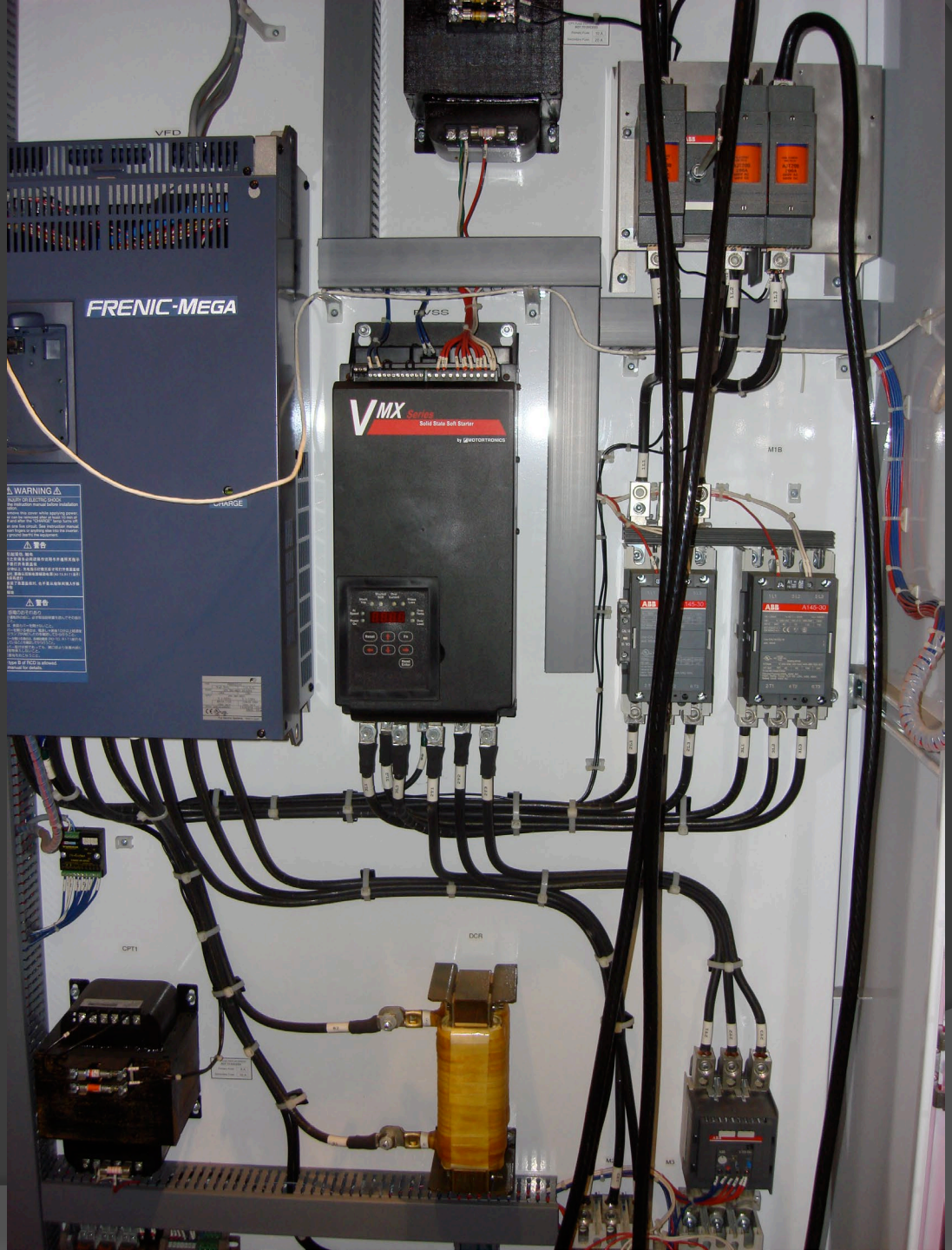
- 20KV
- 138KV
- 345KV
- 500KV
- 750KV

What Voltages are Present?

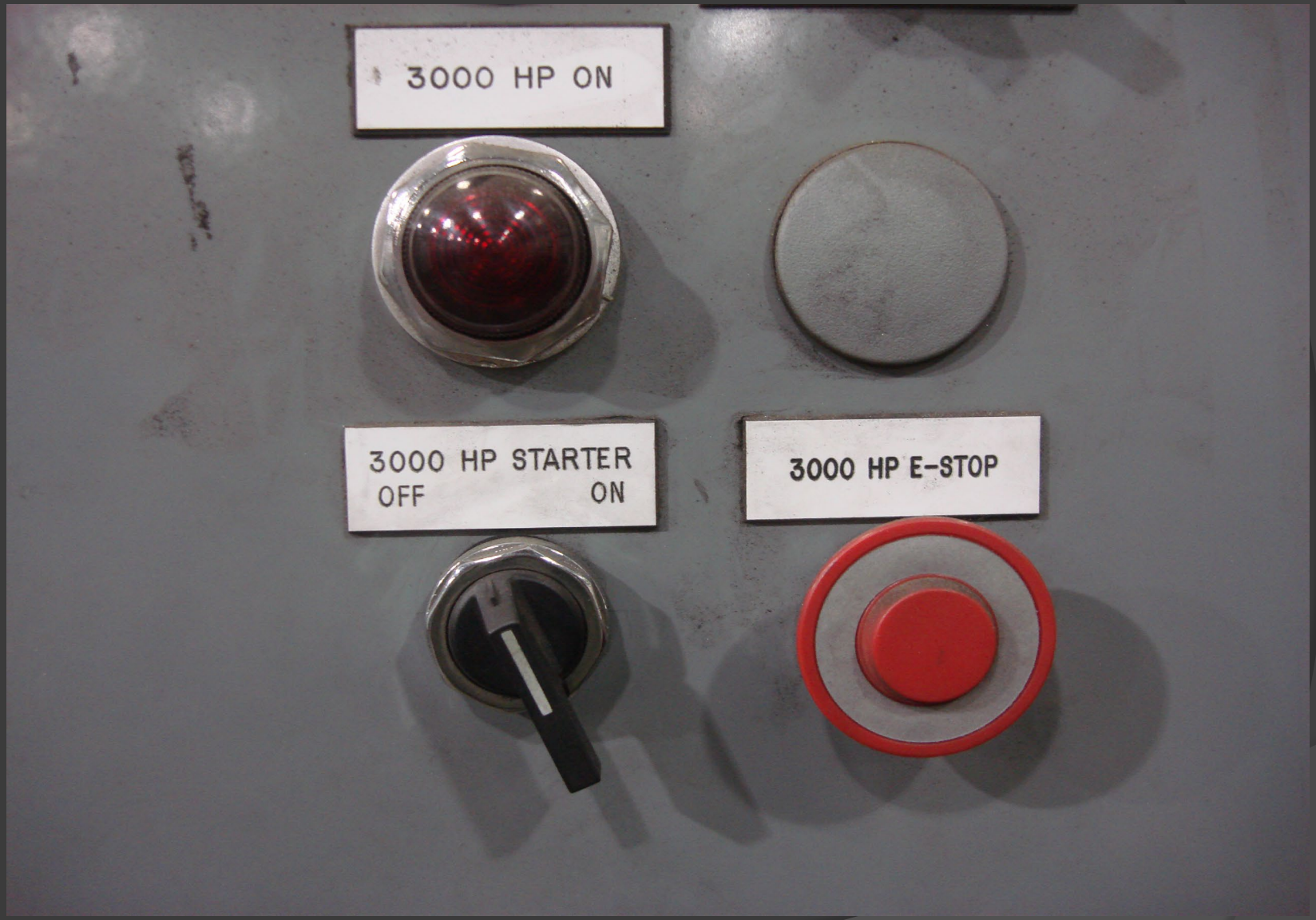
What Voltages are Present?

Do You Have Any Equipment Such As…




VFD
FRENIC-MEGA
CHARGE
⚠ WARNING ⚠
⚠ 警告
⚠ 警告
DVSS
VMX Series
Solid State Soft Starter
by MOTORTRONICS
M1B
ABB
A145-30
A145-30
CPT1
DCR
M3

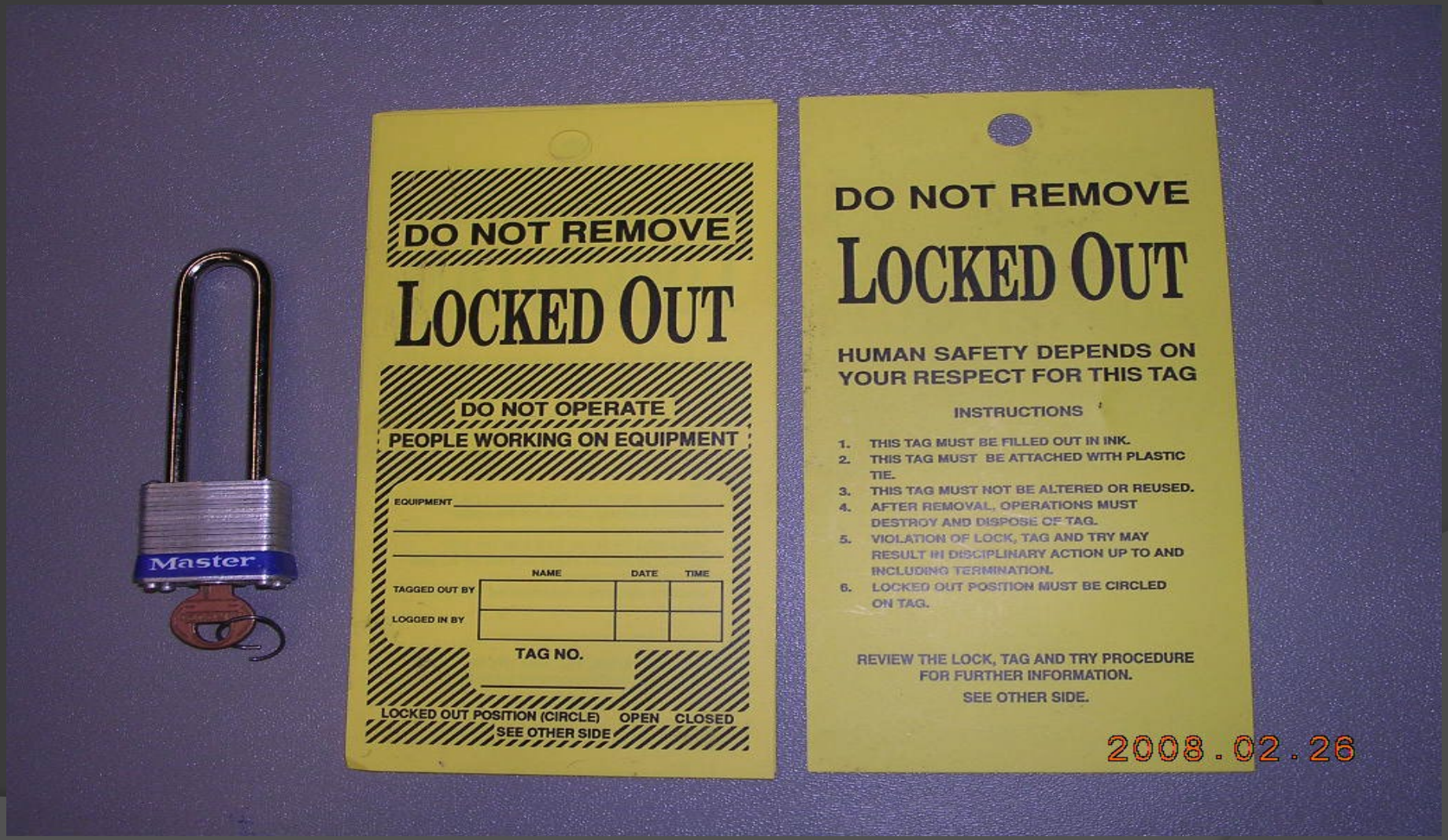

DANGER
HIGH VOLTAGE
WARNING
Qualified Persons Only
Arc Flash and Shock Hazard
308 inch
Flash Protection
Boundary
HRC 3
9.6 cal/cm^2
Flash Hazard at
36 inches
4160 VAC Shock Hazard
1 Glove Class
60 inch Limited Approach
26 inch Restricted Approach
7 inch Prohibited Approach
PPE REQUIRED:
FR Shirt & Pants + Cotton Underwear +
FR Coveralls + Hard Hat w/ FR Liner +
Flash Suit Hood +Safety Glasses +
Hearing Protection + Leather Gloves +
Leather Shoes
PNL: 3000HP STARTER Prot: 3000HP DISC FU
11/19/2007


3000 HP ON
3000 HP STARTER
OFF
ON
3000 HP E-STOP


Rockwell Automation
Allen-Bradley
DANGER
HIGH VOLTAGE
WARNING
HRC 3
CLOSED
OPEN

What Are the Elements of Electrical Safety?

Lockout Tagout



Gloves


9
ANSI/ASTM D120
NORTH
CLASS 00 TYPE 1
MAX. USE VOLTAGE
500V AC, RMS
KUNZ-CHICAGO
9
WEAR OVER SIZE
PROTECTOR
CLASS "00"
10 "O.A.L.
910
2008.02.26

Dated Insulated Gloves

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (13) Arc Flash Protective Equipment.
- (c) Hand Protection. Leather or FR gloves shall be worn where required for arc flash protection. **Where insulating rubber gloves are used for shock protection, leather protectors shall be worn over rubber gloves.**

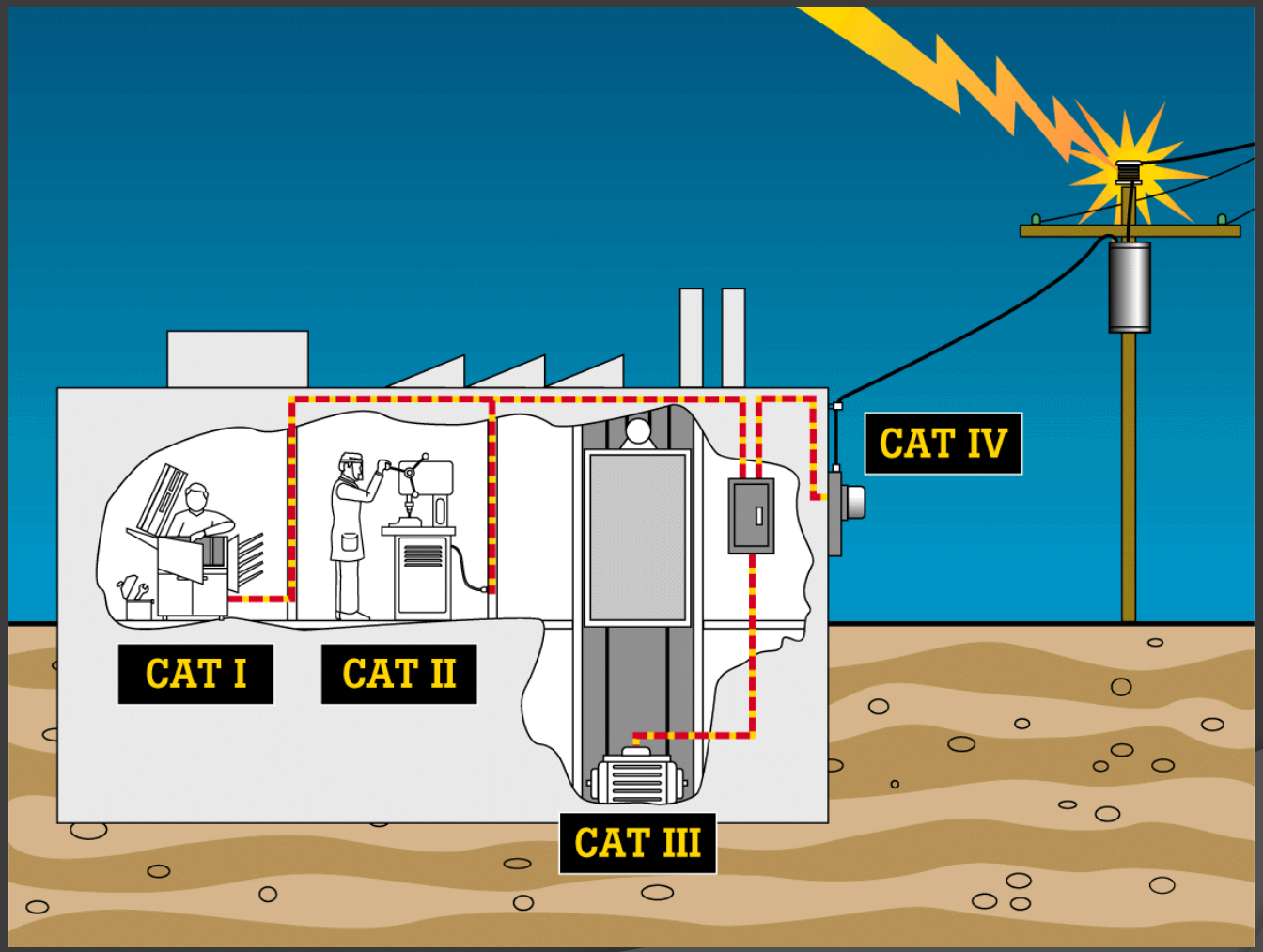
Meter Safety-Does meet requirements of 120.1(5) – NFPA 70E

CAT III-1000 V
CAT IV -600V

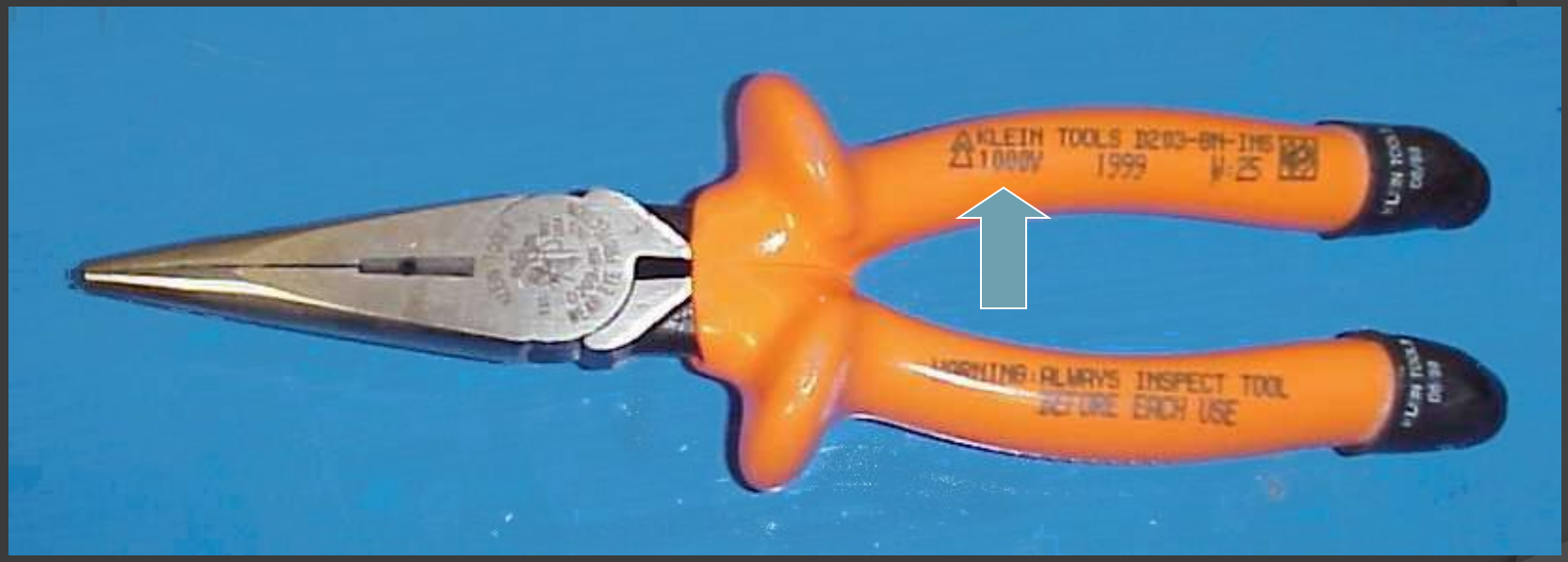
CAT IV-600 V
CAT III-1000 V

CAT III-
600 V

Category locations



Voltage Rated Tools

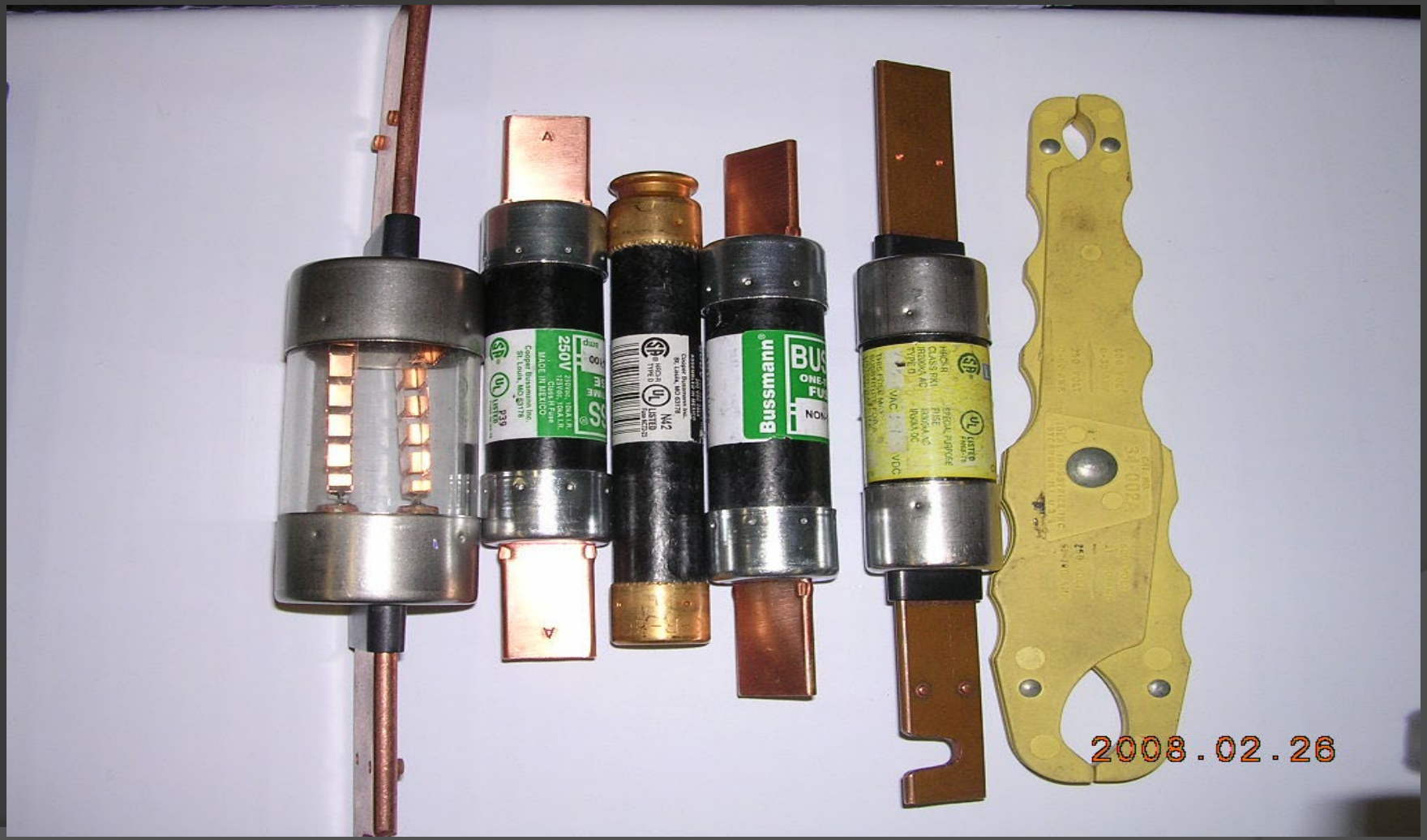


Insulated Screwdrivers


6-PIECE ELECTRICAL SCREWDRIVER
CHROME VANADIUM STEEL FOR LONGER LIFE AND DURABILITY
HARDNESS MEETS OR EXCEEDS SPECS
TASK FORCE® TAIWAN #0X3"
TASK FORCE® TAIWAN #1 X 4"
TASK FORCE® TAIWAN #2 X 6"
TASK FORCE® TAIWAN 1/4"X6"
TASK FORCE® TAIWAN 3/16"X4"
TASK FORCE® TAIWAN 1/8"X3"
CONTENTS: SLOTTED 1/8" X 3", 3/16"X4",1/4"X6" PHILLIPS#0X3", #1X4", #2X6"
2008.02.26


2008.02.26

Fuses



2008.02.26

Based on Voltages & Hazards Present - Establish Procedures

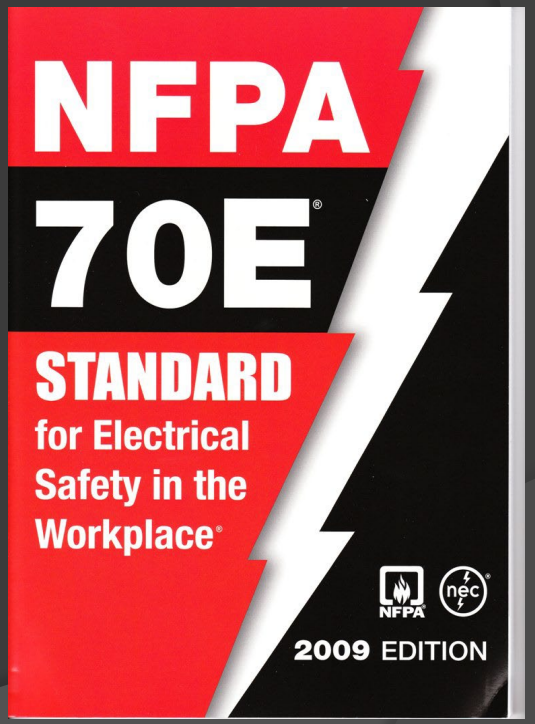
- Determine Voltage & Arc Flash Hazards
- Determine Who is Exposed
- Determine Protective Measures
- Determine OSHA Requirements
- Determine What NFPA 70E Procedures that Will be Followed

How to Evaluate Voltage & Arc Flash Hazard Potential

Before Work Can Proceed On or Near Exposed Energized Parts We Must Perform:

- Shock Hazard Analysis
- Shock Protection Boundary

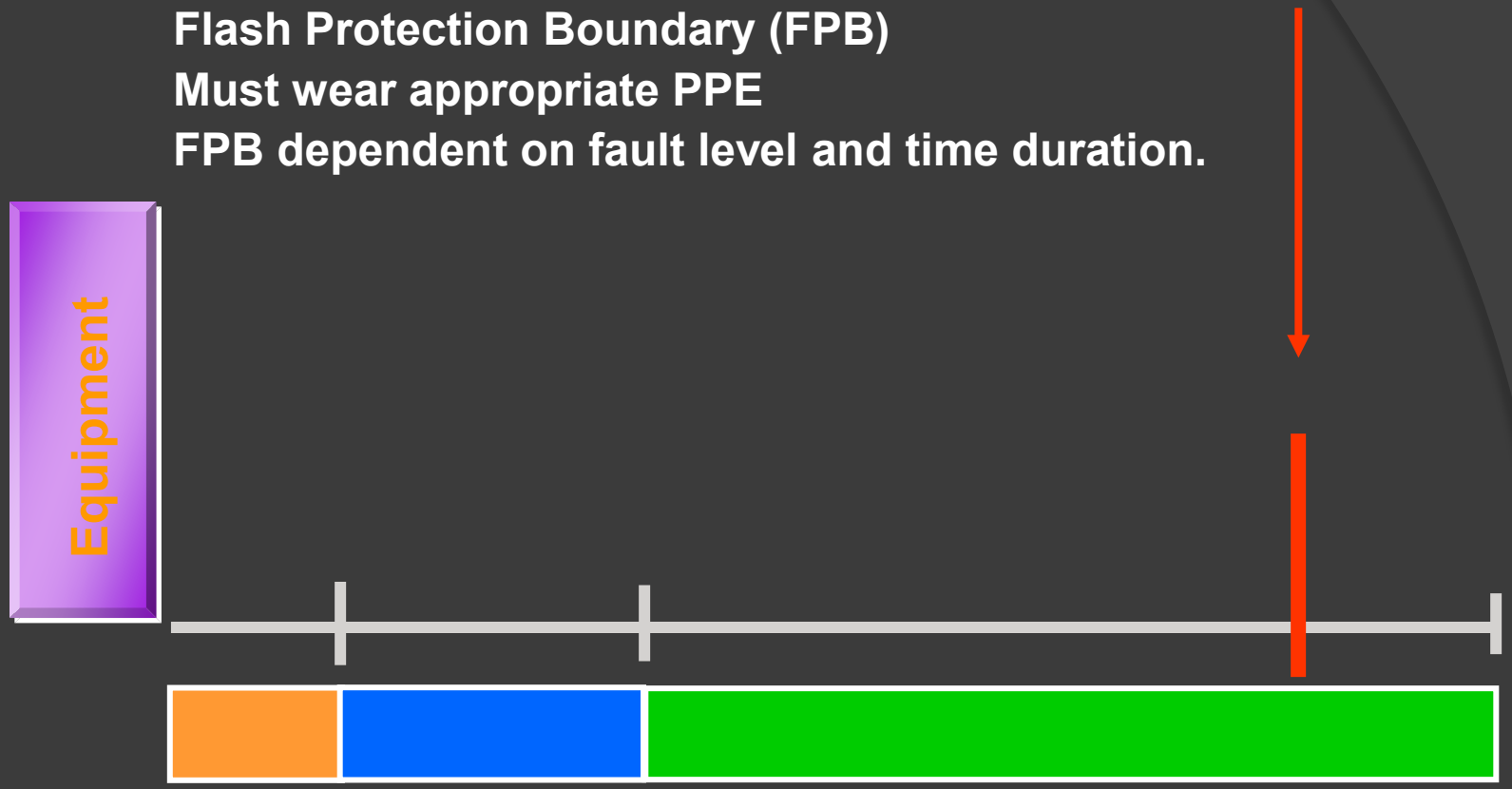
- Arc Flash Analysis
- Arc Flash Boundary



Calorie Studies vs. Tables

- Calorie Studies
  - Performed by Professionals
  - Determines Exact Hazards
  - Costly
- Tables
  - Can be Used Effectively
  - Must Know How to Navigate
  - Can Use to Select Proper PPE

Flash Protection Boundary (FPB)
Must wear appropriate PPE
FPB dependent on fault level and time duration.



Prohibited Shock Boundary: Qualified Persons Only. PPE as if direct contact with live part

Restricted Shock Boundary: Qualified Persons Only

Limited Shock Boundary: Qualified or Unqualified Persons*
* Only if accompanied by Qualified Person

Note: shock boundaries dependent on system voltage level

Limited Approach Boundary

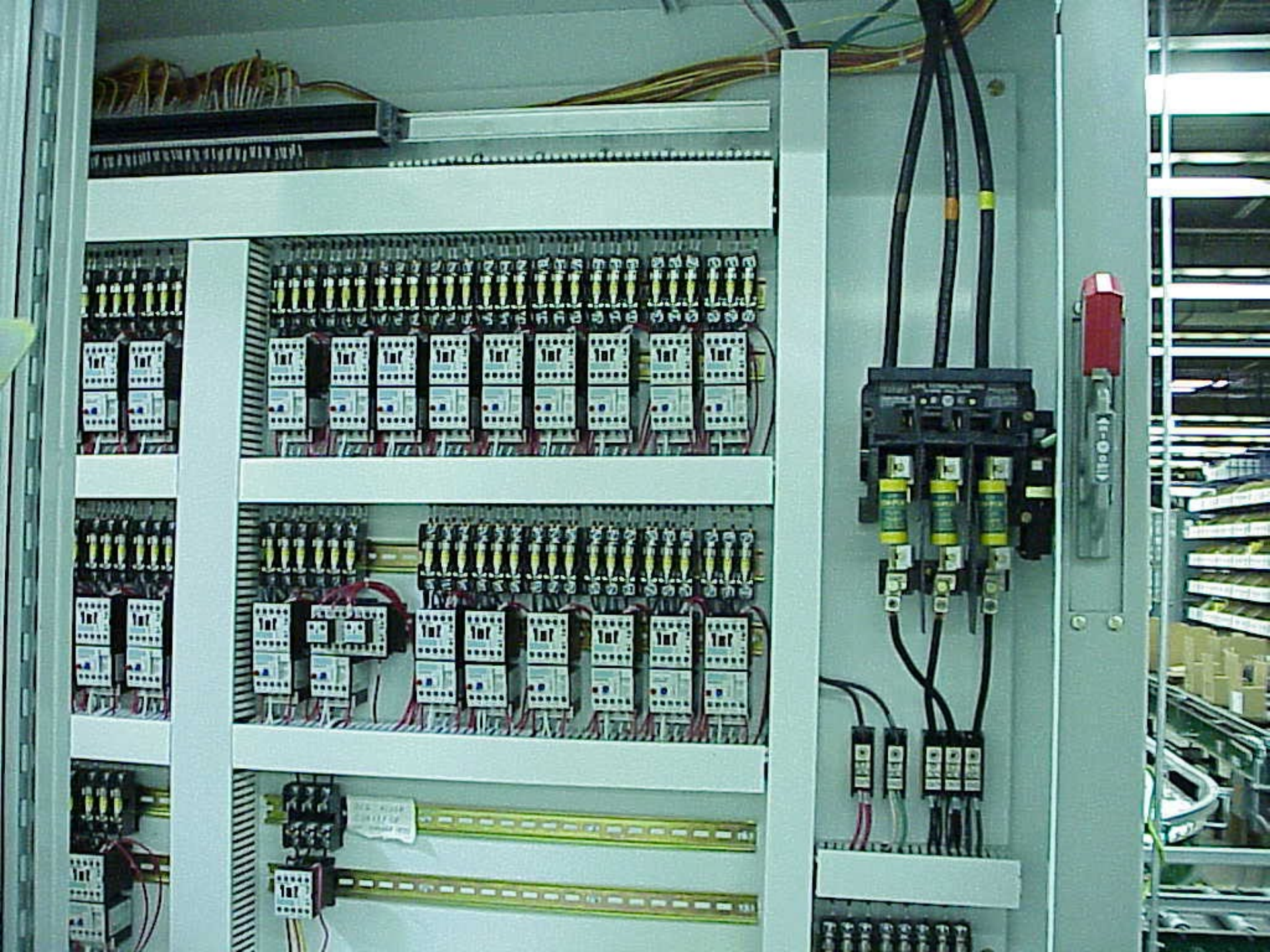
The *limited approach boundary* is a shock protection boundary to be crossed by only qualified persons (at a distance from a live part) which is not to be crossed by unqualified persons unless escorted by a qualified person.

Restricted Approach Boundary

A *restricted approach boundary* is a shock protection boundary to be crossed only by qualified persons (at a distance from a live part) which, due to its proximity to a shock hazard, requires the use of shock protection techniques and equipment when crossed.

Prohibited Approach Boundary

A *prohibited approach boundary* is a shock protection boundary to be crossed only by qualified persons (at a distance from a live part) which, when crossed by a body part or object shall require the same protection as if direct contact is made with a live part.



Default Flash Protection Boundary

- 600 volt systems = 4 feet (Ralph Lee Formulae)
- Above 600 volt systems = distance at which 1.2 cal/cm^2 (slow clearing time)
- Above 600 volt systems = distance at which 1.5 cal/ cm^2 (clearing time of 0.1 sec or less)

This will be different in the NFPA 2012

Selecting Flash Protection

1. Calculate incident energy and select PPE based upon that calculation.
2. Select hazard/risk category based on task, *then* select PPE based upon hazard/risk category.

PPE Selection
Use of Tables Exercise
NFPA 70E

to Table 130.7(C)(9). For tasks not listed, or for power systems with greater than the assumed maximum short-circuit current capacity or with longer than the assumed maximum fault clearing times, an arc flash hazard analysis shall be required in accordance with 130.3.

FPN No. 1: The work tasks and protective equipment identified in Table 130.7(C)(9) were identified by a task group and the protective clothing and equipment selected was based on the collective experience of the task group. The protective clothing and equipment is generally based on determination of estimated exposure levels.

In several cases where the risk of an arc flash incident is considered low, very low, or extremely low by the task group, the hazard/risk category number has been reduced by 1, 2, or 3 numbers, respectively. The collective experience of the task group is that in most cases closed doors do

crease in the opening time of the overcurrent protectiv device, the arc flash energy will increase. If the availabl short-circuit current decreases, resulting in a longer open ing time for the overcurrent protective device, arc flas energies could also increase.

FPN No. 3: Energized electrical conductors or circuit part that operate at less than 50 volts may need to be de energized to satisfy an "electrically safe work condition." Consideration should be given to the capacity of the source any overcurrent protection between the energy source and the worker, and whether the work task related to the source operating at less than 50 volts increases exposure to elec trical burns or to explosion from an electric arc.

FPN No. 4: See 130.1(B)(2)(6) for requirements on docu menting the available short-circuit current and fault clear ing time.

Table 130.7(C)(9) Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand To
Panelboards or Other Equipment Rated 240 V and Below — Note 1			
Perform infrared thermography and other non contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) — Note 1			

Table 130.7(C)(9) *Continued*

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard or switchboard	2*	Y	Y
600 V Class Motor Control Centers (MCCs) — Note 2 (except as indicated)			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC — Note 3	4	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts) — Note 3	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts) — Note 3	1	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center	2*	Y	Y
600 V Class Switchgear (with power circuit breakers or fused switches) — Note 4			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N

Table 130.7(C)(9) *Continued*

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Metal Clad Switchgear, 1 kV Through 38 kV			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
CB operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB operation with enclosure doors open	4	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N
Arc-Resistant Switchgear Type 1 or 2 (for clearing times of <0.5 sec with a perspective fault current not to exceed the arc resistant rating of the equipment)			
CB operation with enclosure door closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	0	N	N
Insertion or removal of CBs from cubicles with door open	4	N	N
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage transformers on or	0	N	N

Table 130.7(C)(9) ***Continued***

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Other Equipment 1 kV Through 38 kV			
Metal-enclosed interrupter switchgear, fused or unfused			
Switch operation of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Switch operation, doors closed	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

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 (½ 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.

(10) Protective Clothing and Personal Protective Equipment Matrix. Once the Hazard/Risk Category has been identified from Table 130.7(C)(9) (including associated notes) and the requirements of 130.7(C)(9), Table 130.7(C)(10) shall be used to determine the required PPE for the task. Table 130.7(C)(10) lists the requirements for protective clothing and other protective equipment based on Hazard/Risk Category numbers 0 through 4. This clothing and equipment shall be used when working within the

FPN No. 1: See Annex H for a suggested simplified approach to ensure adequate PPE for electrical workers within facilities with large and diverse electrical systems.

FPN No. 2: The PPE requirements of this section are intended to protect a person from arc flash and shock hazards. While some situations could result in burns to the skin, even with the protection described in Table 130.7(C)(10), burn injury should be reduced and survivable. Due to the explosive effect of some arc events, physical trauma injuries could occur. The PPE requirements of this section do

(11) Protective Clothing Characteristics. Table 130.7(C)(11) lists examples of protective clothing systems and typical characteristics, including the degree of protection, for various clothing. The protective clothing selected for the corresponding Hazard/Risk Category number determined from Table 130.7(C)(9) (including associated notes) and the requirements of 130.7(C)(9) shall have an arc rating of at least the value listed in the last column of Table 130.7(C)(11).

FPN: The arc rating for a particular clothing system can be obtained from the FR clothing manufacturer.

Table 130.7(C)(11) Protective Clothing Characteristics

Hazard/Risk Category	Clothing Description	Required Minimum Arc Rating of PPE [J/cm^2(cal/cm^2)]
0	Nonmelting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd^2	N/A
1	Arc-rated FR shirt and FR pants or FR coverall	16.74 (4)
2	Arc-rated FR shirt and FR pants or FR coverall	33.47 (8)
3	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	104.6 (25)
4	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	167.36 (40)

Note: Arc rating is defined in Article 100 and can be either ATPV or E_{BT}. ATPV is defined in ASTM F 1959, *Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing*, as the incident energy on a material or a multilayer system of

equipment required for the degree of exposure shall be permitted to be worn alone or integrated with flammable, nonmelting apparel. If FR clothing is required, it shall cover associated parts of the body as well as all flammable apparel while allowing movement and visibility. All personal protective equipment shall be maintained in a sanitary and functionally effective condition. Personal protective equipment items will normally be used in conjunction with one another as a system to provide the appropriate level of protection.

FPN: Protective clothing includes shirts, pants, coveralls, jackets, and parkas worn routinely by workers who, under normal working conditions, are exposed to momentary electric arc and related thermal hazards. Flame-resistant rainwear worn in inclement weather is included in this category of clothing.

(a) Layering. Nonmelting, flammable fiber garments shall be permitted to be used as underlayers in conjunction with FR garments in a layered system for added protection. If nonmelting, flammable fiber garments are used as underlayers, the system arc rating shall be sufficient to prevent breakopen of the innermost FR layer at the expected arc exposure incident energy level to prevent ignition of flammable underlayers.

FPN: A typical layering system might include cotton underwear, a cotton shirt and trouser, and a FR coverall. Specific tasks might call for additional FR layers to achieve the required protection level.

(b) Outer Layers. Garments worn as outer layers over FR clothing, such as jackets or rainwear, shall also be made from FR material.

(c) Underlayers. Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers (underwear) next to the skin.

Exception: An incidental amount of elastic used on nonmelting fabric underwear or socks shall be permitted.

FPN No. 1: FR garments (e.g., shirts, trousers, and coveralls) worn as underlayers that neither ignite nor melt and drip in the course of an exposure to electric arc and related thermal hazards generally provide a higher system arc rating than nonmelting, flammable fiber underlayers.

FPN No. 2: FR underwear or undergarments used as underlayers generally provide a higher system arc rating than nonmelting, flammable fiber underwear or undergarments used as underlayers.

Hazard/ Risk Category	Clothing Description (Typical number of clothing layers is given in parentheses)	Required Minimum Arc Rating of PPE (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 4.5 oz/yd^2 (1)	N/A
1	FR shirt and FR pants or FR coverall (1)	4
2	Cotton underwear – conventional short sleeve and brief/shorts, plus FR shirt and FR pants (1 or 2)	8
3	Cotton underwear plus FR shirt and FR pants plus FR coverall, or cotton underwear plus two FR coveralls (2 or 3)	25
4	Cotton underwear plus FR shirt and FR pants plus multilayer flash suit (3 or more)	40

Table 130.7(C)(10) Protective Clothing and Personal Protective Equipment (PPE)

Hazard/Risk Category	Protective Clothing and PPE
Hazard/Risk Category 0	
Protective Clothing, Nonmelting (according to ASTM F 1506-00) or Untreated Natural Fiber	Shirt (long sleeve) Pants (long)
FR Protective Equipment	Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
Hazard/Risk Category 1	
FR Clothing, Minimum Arc Rating of 4 (Note 1)	Arc-rated long-sleeve shirt (Note 3) Arc-rated pants (Note 3) Arc-rated coverall (Note 4) Arc-rated face shield or arc flash suit hood (Note 7) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes (AN)
Hazard/Risk Category 2	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated face shield or arc flash suit hood (Note 7) Arc rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 2*	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated arc flash suit hood (Note 10) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes

Table 130.7(C)(10) ***Continued***

Hazard/Risk Category	Protective Clothing and PPE
FR Protective Equipment	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
Hazard/Risk Category 4	
FR Clothing, Minimum Arc Rating of 40 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 9) Arc-rated pants (AR) (Note 9) Arc-rated coverall (AR) (Note 9) Arc-rated arc flash suit jacket (AR) (Note 9) Arc-rated arc flash suit pants (AR) (Note 9) Arc-rated arc flash suit hood (Note 9) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	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

AN = As needed (optional)
AR = As required
SR = Selection required
Notes:
1. See Table 130.7(C)(11). Arc rating for a garment or system of garments is expressed in cal/cm^2.
2. If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
3. The FR shirt and pants used for Hazard/ Risk Category 1 shall have a minimum arc rating of 4.
4. Alternate is to use FR coveralls (minimum arc rating of 4) instead of FR shirt and FR pants.
5. FR shirt and FR pants used for Hazard/ Risk Category 2 shall have a minimum arc rating of 8.
6. Alternate is to use FR coveralls (minimum arc rating of 8) instead of FR shirt and FR pants.
7. A face shield with a minimum arc rating of 4 for Hazard/Risk Category 1 or a minimum arc rating of 8 for Hazard/Risk Category 2, with wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or, alternatively, an arc-rated arc flash suit hood), is required.
8. An alternate is to use a total FR clothing system and hood, which shall have a minimum arc rating of 25 for Hazard/Risk Category 3.
9. The total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.
10. Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face, head and neck except for the eye and nose areas.

Arc-Flash Hazard/Risk Categories - Required Clothing - Required PPE
Fermilab Summary for NFPA 70E

Calculated Exposure from Prospective Arc-Flash	Hazard/Risk Category	Minimum Required ATPV	Clothing Requirements	Additional PPE
Zero up to 1.2 cal/cm^2	0	NA	Long Sleeve Cotton Shirt and Pants	Safety Glasses
More than 1.2 and up to 4 cal/cm^2	1	4 cal/cm^2	FR Coverall*	Hard Hat, Safety Glasses
More than 4 and up to 8 cal/cm^2	2	8 cal/cm^2	Cotton Clothing Under FR Coverall*	Hard Hat, Safety Glasses, Face Shield, Hearing Protection, Leather Gloves, Leather Work Shoes
More than 4 and up to 8 cal/cm^2	2*	8 cal/cm^2	Cotton Clothing Under FR Coverall*	Hard Hat, Safety Glasses, Double-Layer Switching Hood, Hearing Protection, Leather Gloves, Leather Work Shoes
More than 8 and up to 25 cal/cm^2	3	25 cal/cm^2	Cotton Clothing Under 2 x FR Coveralls*	Hard Hat, Safety Glasses, Flash Suit Hood, Hearing Protection, Leather Gloves, Leather Work Shoes
More than 25 and up tp 40 cal/cm^2	4	40 cal/cm^2	Cotton Clothing Under FR Coverall* plus Multilayer Flash Suit Jacket & Pants	Hard Hat, Safety Glasses, Flash Suit Hood, Hearing Protection, Leather Gloves, Leather Work Shoes

* Coverall Rated at 8 cal/cm^2 Available from Fermilab Stockroom

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (A) General.
- (B) Care of Equipment.
- (C) Personal Protective Equipment.
- (D) Other Protective Equipment.
- (E) Alerting Techniques.
- (F) Standards for Other Protective Equipment.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (A) General.
- Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body to be protected and for the work to be performed.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (A) General.
- (B) Care of Equipment.
- Protective equipment shall be maintained in a safe, reliable condition. The protective equipment shall be visually inspected before each use.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (1) General.
- When an employee is working within the Flash Protection Boundary he/she shall wear protective clothing and other personal protective equipment in accordance with 130.3.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (2) Movement and Visibility.
- When flame-resistant (FR) clothing is worn to protect an employee, ***it shall cover all ignitable clothing and shall allow for movement and visibility.***

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (3) Head, Face, Neck, and Chin Protection. Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with live parts or from flying objects resulting from electrical explosion.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (3) Head, Face, Neck, and Chin Protection cont'd. Employees shall wear nonconductive protective equipment for the face, neck, and chin whenever there is a danger of injury from exposure to electric arcs or flashes or from flying objects resulting from electrical explosion.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (4) Eye Protection. Employees shall wear protective equipment for the eyes whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (5) Body Protection. Employees shall wear FR clothing whenever there is a possible exposure to an electric arc flash above the threshold incident-energy level for a second-degree burn, 5 J/cm2 (1.2 cal/cm2).

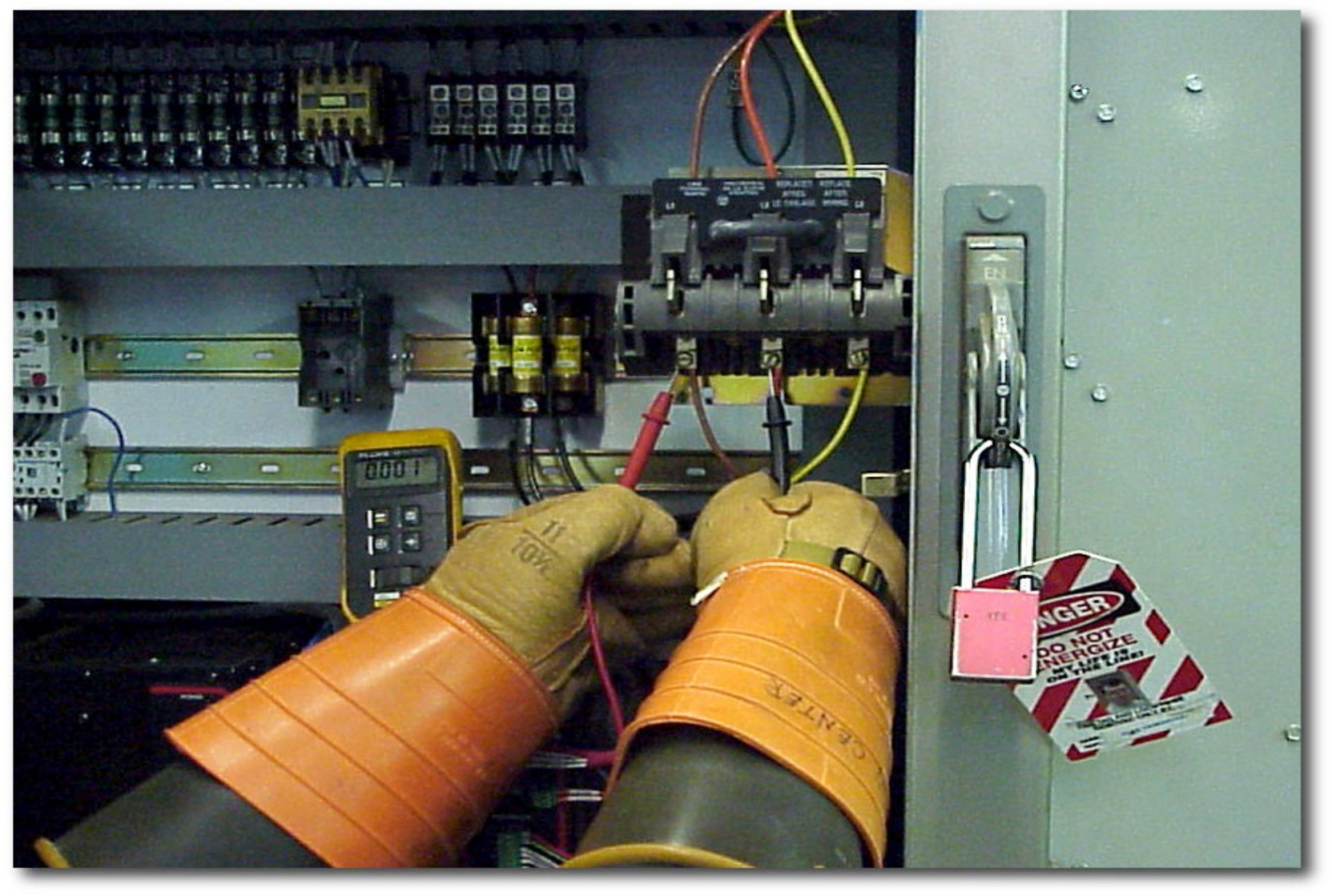
This is closer to what it should look like!

This is what NFPA 70E suggests, and what OSHA expects!

OSHA 1910.335(a)(1)(i)

NFPA 70E Table 3-3.9.1 / 3-3.9.2

This is how it SHOULD be done!!!!!!!!!!



Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (6) Arm and Hand Protection. Employees shall wear rubber insulating gloves where there is a danger of hand and arm injury from electric shock due to contact with live parts.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (b) Outer Layers. Garments worn as outer layers over FR clothing, such as jackets or rainwear, shall also be made from FR material.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (c) Underlayers. Meltable fibers such acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers (underwear) next to the skin.

Article 130
Working On or Near Live Parts

- **130.7 Personal and Other Protective Equipment.**
- (C) Personal Protective Equipment.
- (d) Coverage. Clothing shall cover potentially exposed areas as completely as possible. Shire sleeves shall be fastened at the wrists, and shirts and jackets shall be closed at the neck.

NFPA 70E – 2009

Section 130.3(C)
NFPA 70E – 2009

Arc Flash Hazard
Marking Requirement

Label Electrical Systems

WARNING

Arc Flash and Shock Hazard
Appropriate PPE Required

24 inch	Flash Hazard Boundary
3	cal/cm² Flash Hazard at 18 inches
1	PPE Level, 1 Layer 6 oz. Nomex, Leather Gloves Faceshield
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: MIDWEST

WARNING

Arc Flash & Shock Hazard
Appropriate PPE Required

Flash Hazard Category _____ Flash Protection Boundary _____

Min. Arc Rating (cal/cm²) _____ Limited Approach Boundary _____

_____ Volt A/C Shock Hazard When: Restricted Approach Boundary _____

_____ Prohibited Approach Boundary _____

FLASH PPE

☐ Cotton underwear	☐ FR shirt	☐ Hard hat	☐ Leather gloves
☐ short - sleeve shirt	☐ FR pants	☐ Face shield	☐ Voltage gloves
☐ Long - sleeve shirt	☐ FR coveralls	☐ Ear protection	☐ Leather shoes
☐ Long pants (jeans)	☐ Hash suit	☐ Safety glasses	☐
☐	☐ Hash hood	☐ Safety goggles	☐

SHOCK PPE

☐ Class _____

☐ V-Rating _____

Equipment ID:

WARNING

Arc Flash Hazard
Appropriate PPE Required

Do not operate controls or open covers without appropriate personal protection equipment.
Failure to comply may result in injury or death!

Refer to NFPA 70E for minimum PPE requirements.

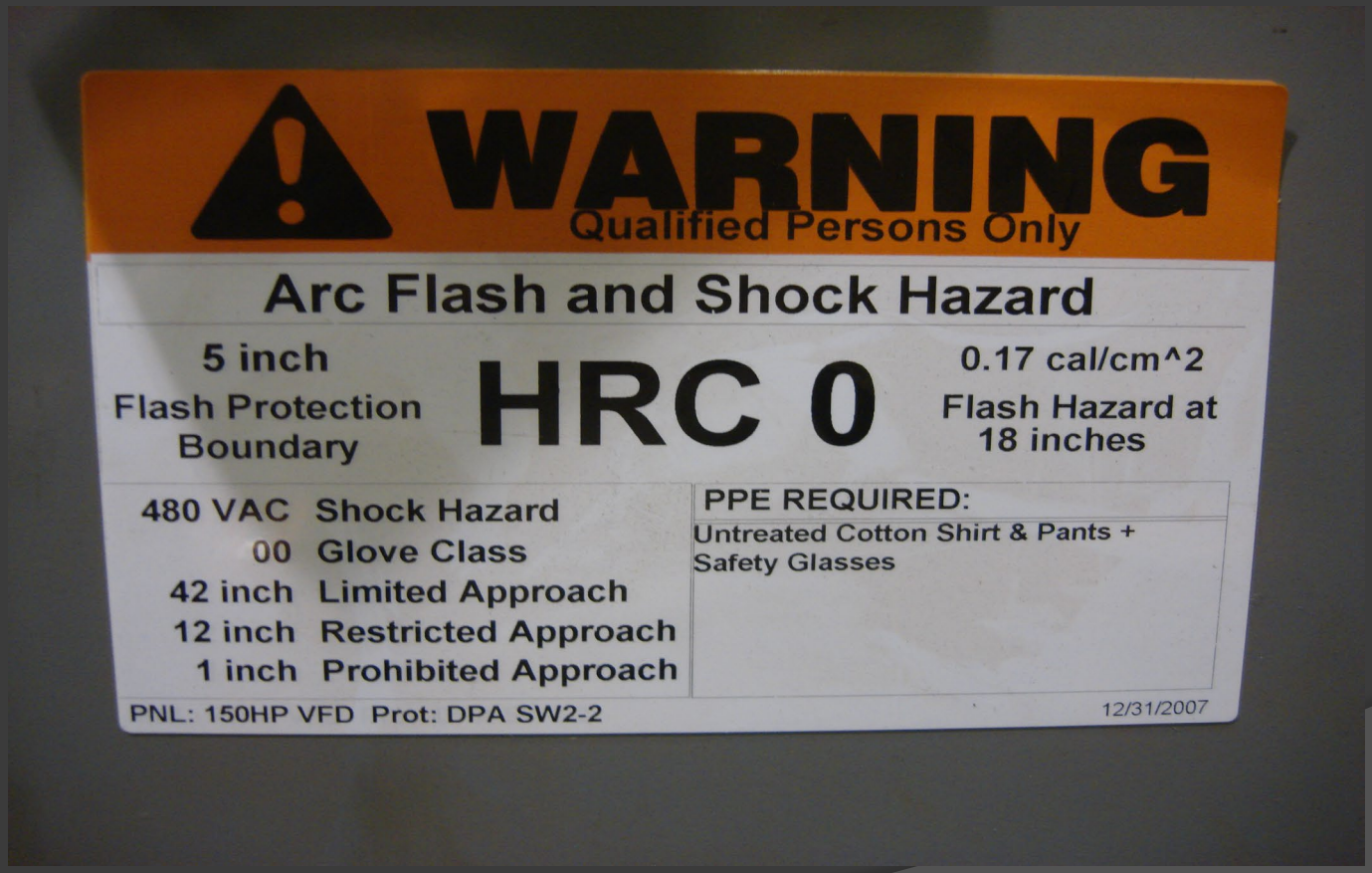
BRADY® CATALOG NO. 99452

New for 2002 NEC Article 110.16 Flash Protection

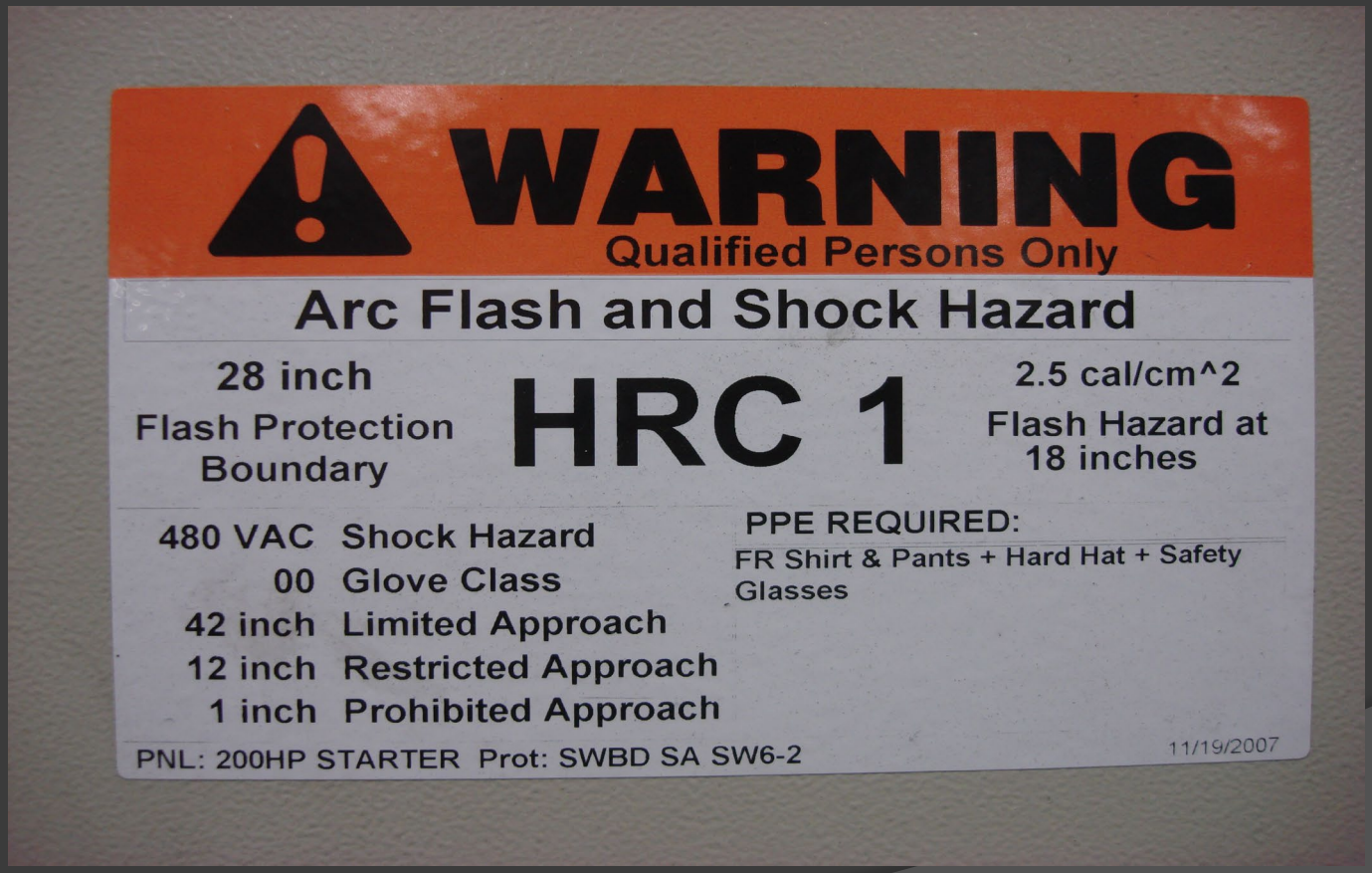
Switchboards, panelboards, industrial control panels and motor control centers that are subject to servicing or maintenance while energized, shall be field marked to warn of potential arc flash hazards. OSHA recognizes all NEC standards. Refer to NFPA 70 E.

BRADY® MS402918

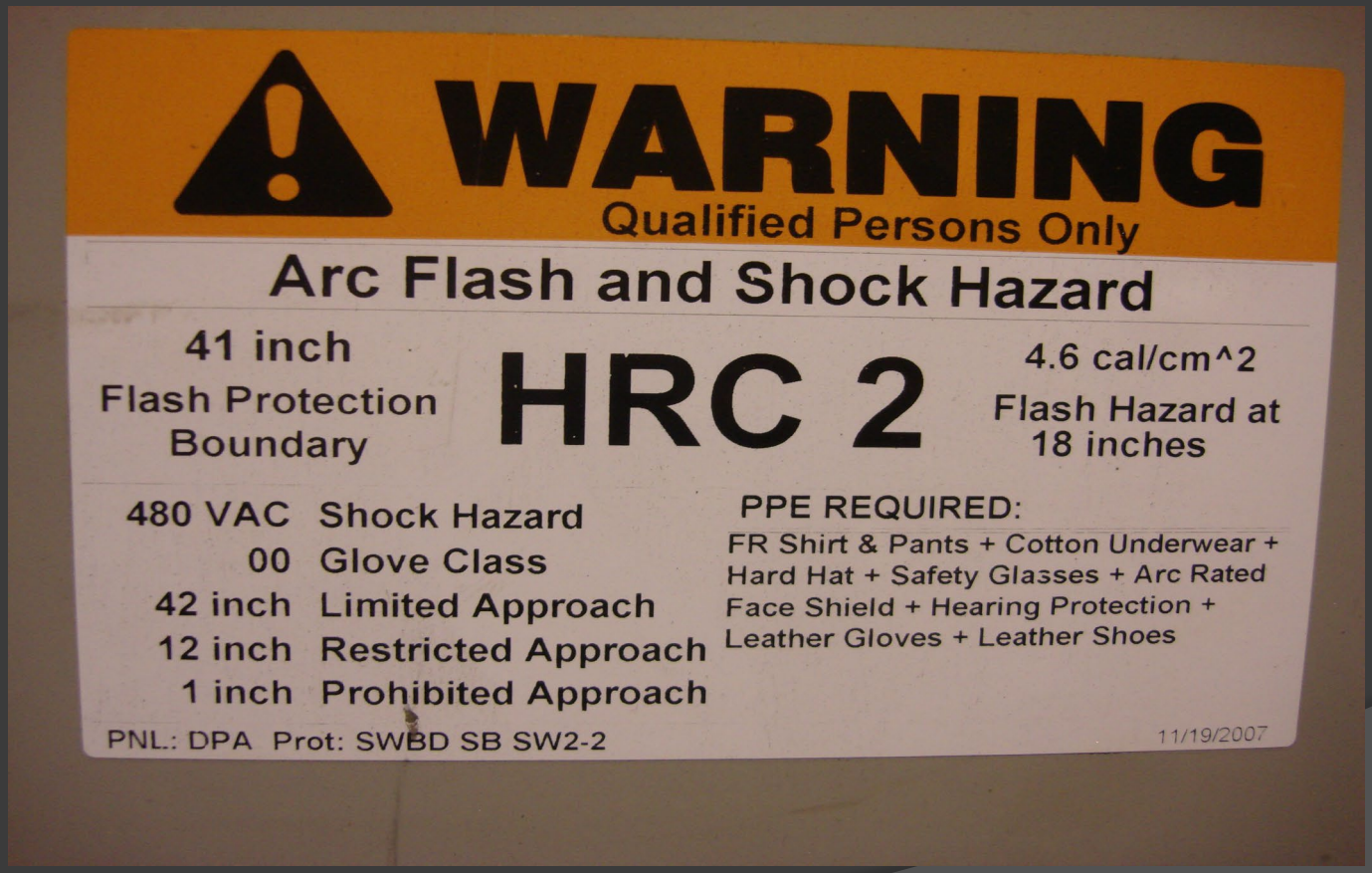
Label Electrical Systems



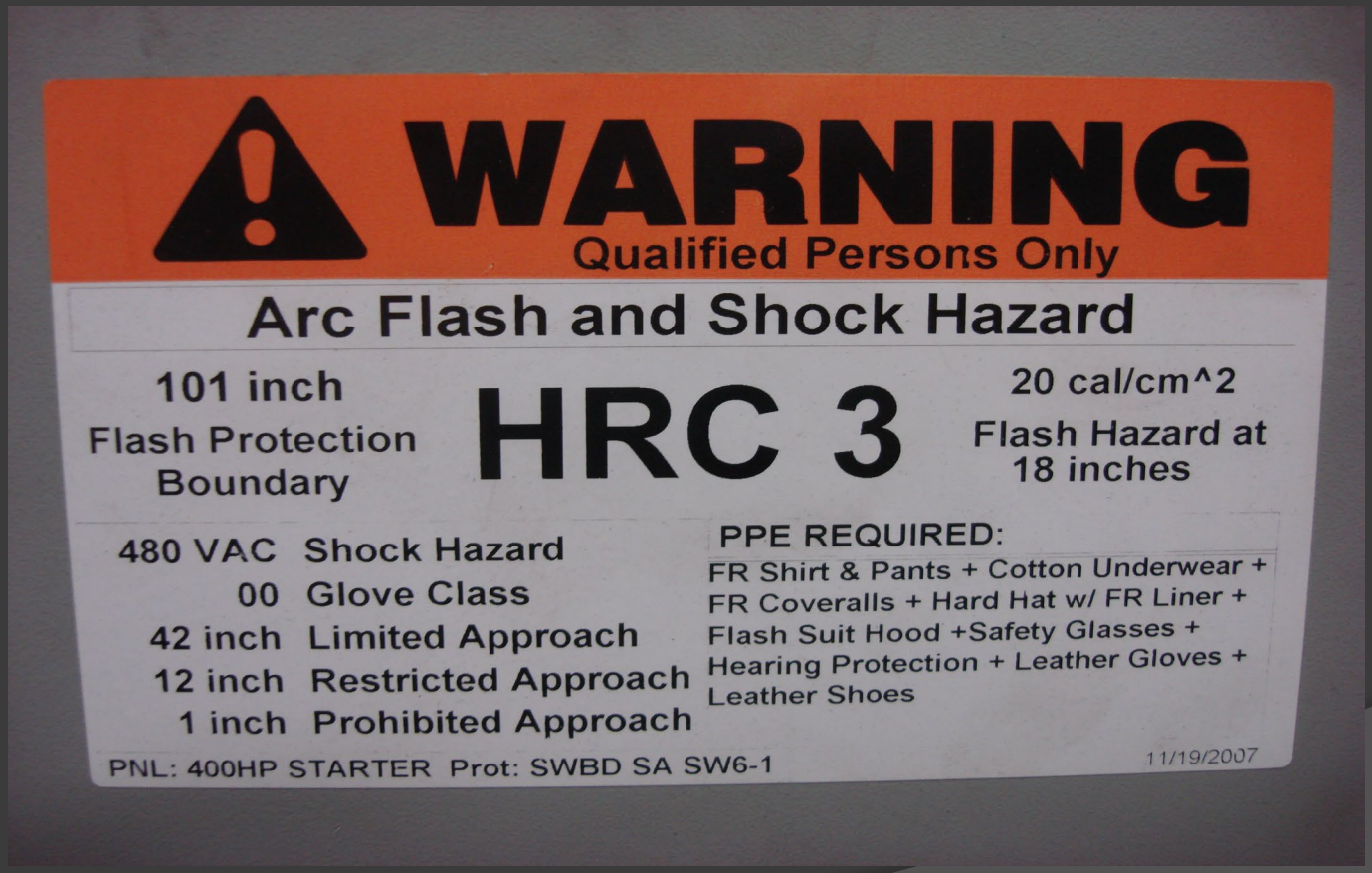
Label Electrical Systems



Label Electrical Systems



Label Electrical Systems




Steven J. Owen
Electrical Consultant
Electrical Safety
Procedures & Requirements
DANGER
DO NOT OPERATE

Arc Flash Rated Face Shield


2008.02.26


CANTEX
CIP
Certified Insulated Products
2008.02.26

Balaclava Sock Hood


réutilisables, avec cordon
Tapones reutilizables
con cordón para los oídos
una colocación sencilla y los
hace más cómodos
Corded Design Prevents
Lost Earplugs
Le cordon prévient la perte
des bouchons d'oreille
Su diseño con cordón evita
que se pierdan los tapones
NRR 25 dB
AOSafety
1 pair
paire
par
2008.02.26


2008.02.26


2008.02.26

This is closer to what it should look like!

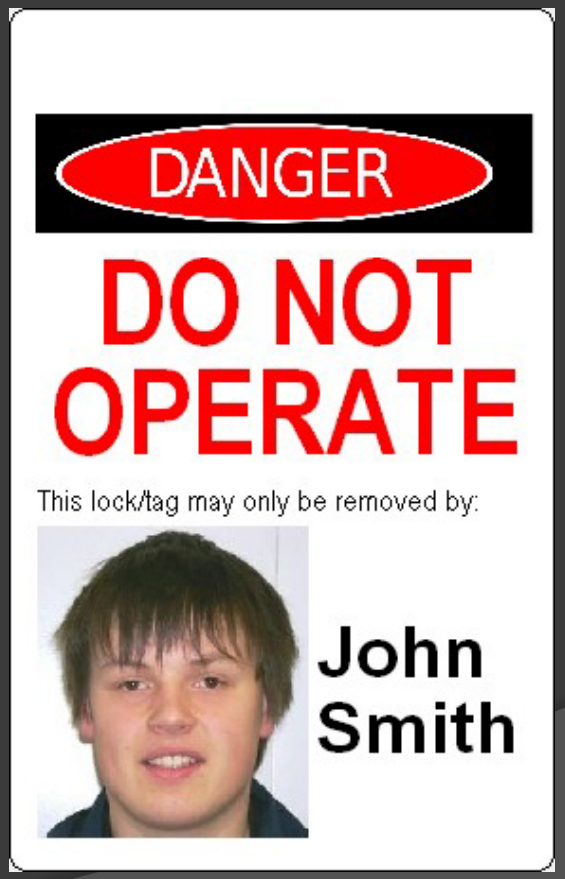
Can you find the shortcoming of this PPE for a Hazard Classification 2 ?

(480/277 VAC)

Preventing Electrical Accidents – Safe Work Practices

Lockout Tagout Program

- Written Program
- Equipment Specific Procedures
- Individual Locks & Tags
- Employee Training- Demonstration of Competency
- Periodic Inspection



Lockout Tagout

- Infeasible

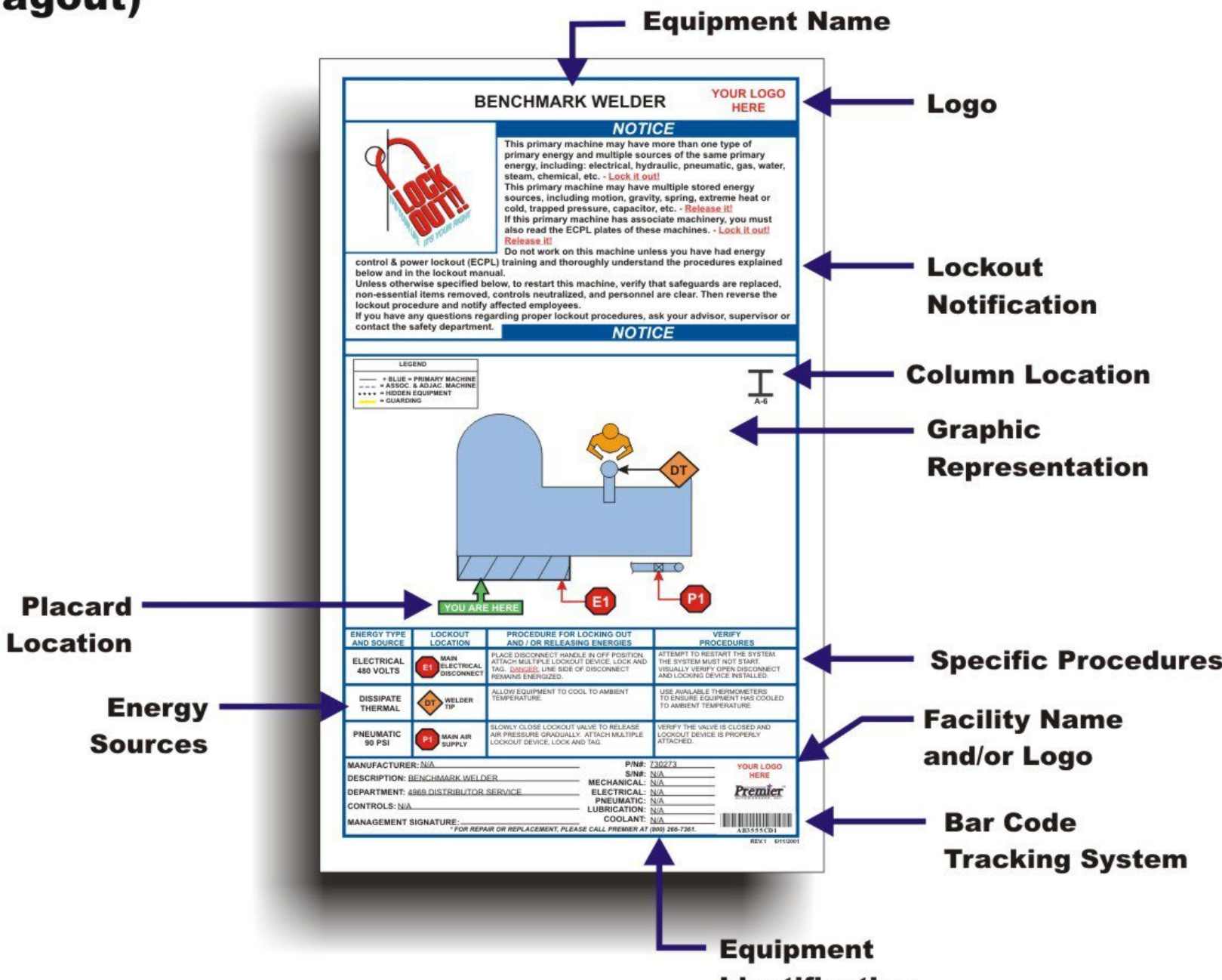
Vs.

- Inconvenient

Scope

- This standard covers the servicing and maintenance of machines and equipment in which the "unexpected" energization or start up of the machines or equipment, or release of stored energy could cause injury to employees.

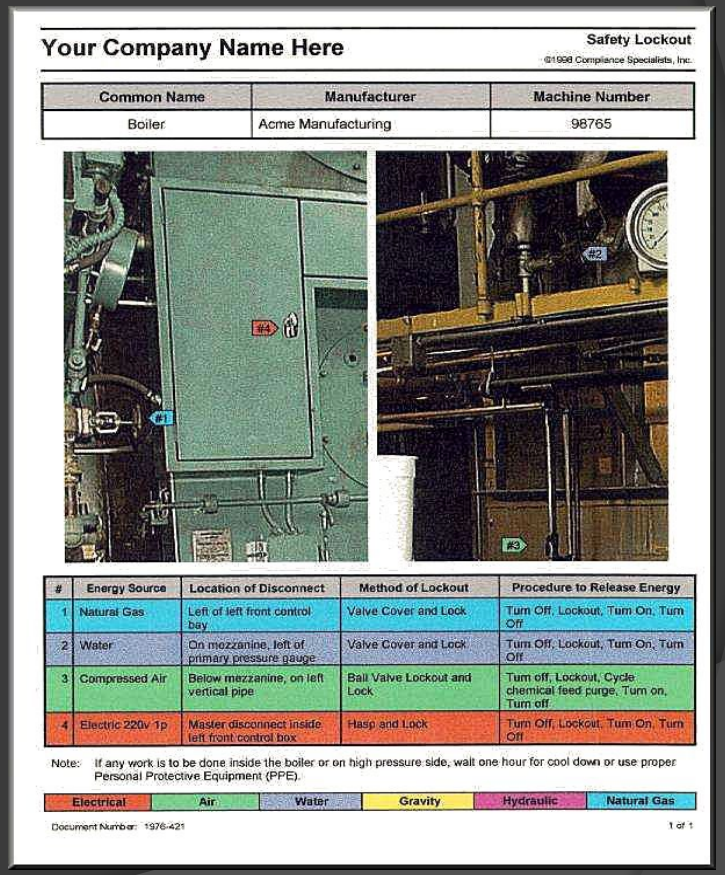
29CFR1910.147
Control of Hazardous Energy (Lockout/Tagout)



Safe Work Practices

The Control of Hazardous Energy - Lockout Tagout

- Lockout/Tagout in PSM
  - Why not Use Digital Imaging in Your Procedures to Identify Critical Lockout /Tagout Positions



Your Company Name Here

Safety Lockout

©1998 Compliance Specialists, Inc.

Common Name	Manufacturer	Machine Number
Boiler	Acme Manufacturing	98765

#	Energy Source	Location of Disconnect	Method of Lockout	Procedure to Release Energy
1	Natural Gas	Left of left front control bay	Valve Cover and Lock	Turn Off, Lockout, Turn On, Turn Off
2	Water	On mezzanine, left of primary pressure gauge	Valve Cover and Lock	Turn Off, Lockout, Turn On, Turn Off
3	Compressed Air	Below mezzanine, on left vertical pipe	Ball Valve Lockout and Lock	Turn off, Lockout, Cycle chemical feed purge, Turn on, Turn off
4	Electric 220v 1p	Master disconnect inside left front control box	Hasp and Lock	Turn Off, Lockout, Turn On, Turn Off

Note: If any work is to be done inside the boiler or on high pressure side, wait one hour for cool down or use proper Personal Protective Equipment (PPE).

Electrical	Air	Water	Gravity	Hydraulic	Natural Gas

Document Number: 1976-421

1 of 1

THE SIX STEPS TO LOCKOUT TAGOUT

1. Preparation for Shutdown

- Before an authorized or affected employee turns off a machine or equipment:
- The authorized employee shall have knowledge of the type and magnitude of the energy;
- The hazards of the energy to be controlled, and the method or means to control the energy

2. Machine or Equipment Shutdown

- The machine or equipment shall be turned off or shut down using the procedures established for the machine or equipment
- An orderly shutdown must be utilized to avoid any additional or increased hazard(s) to employees as a result of the equipment stoppage

3. Machine or Equipment Isolation

- All energy isolating devices that are needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from the energy source(s)

4. Lockout device application

- Lockout or tagout devices shall be affixed to each energy isolating device by authorized employees

5. Stored Energy

- Following the application of lockout devices to energy isolating devices, all potentially hazardous stored or residual energy shall be:
  - Relieved,
  - Disconnected,
  - Restrained, and
  - Otherwise rendered safe

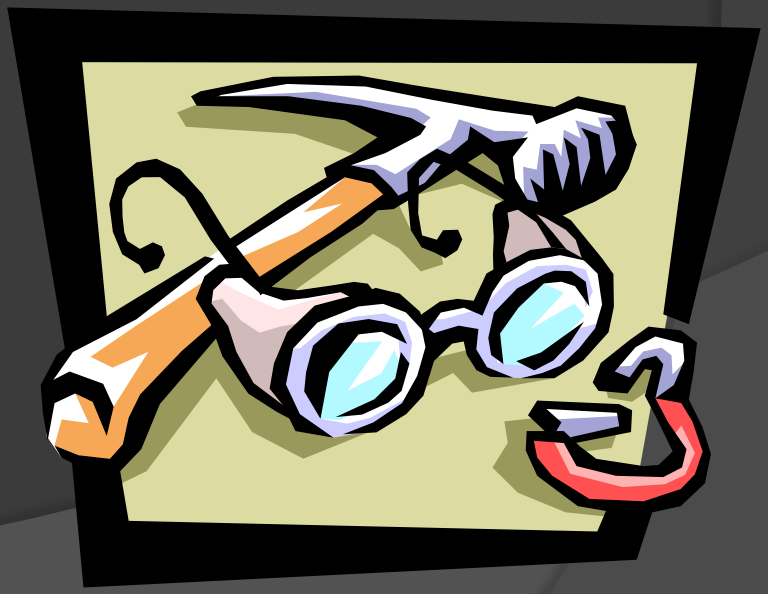
6. Verification of Isolation

- Prior to starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and deenergization of the machine or equipment have been accomplished*

***Verify the isolation of the equipment by operating the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.**
Caution: Return operating control(s) to neutral or "off" position after verifying the isolation of the equipment.

Release from Lockout

- The work area shall be inspected to ensure that nonessential items have been removed and to ensure that machine or equipment components are operationally intact



Safe Work Practices

The Control of Hazardous Energy - Lockout Tagout

- **Lockout Tagout**
- **Must be Followed to the Letter!**

Lockout Tagout Summary

- Have a Well Written Program
- Develop Clear Equipment Specific Procedures and Test Them
- Have all Necessary Lockout Tagout Equipment
- Locks and Tags – Singularly Identifiable
- Train Affected and Authorized Employees
- Authorized Training must include demonstration of competency
- Perform a Periodic (annual) inspection (audit) of the entire program

How to Establish an Electrical Safety Program – It's Not Your Lockout Tagout Program

ELECTRICAL SAFETY PROGRAM

A plan designed so that neither workplace conditions, nor the actions of people, expose personnel unnecessarily to electrical hazards

CONTENT OF PROGRAM
What Every Company Needs

Management Commitment

Organizational Support

Electrical Safety Policy

CONTENT OF PROGRAM

Training and Qualification of Personnel

Proper Use of Protective Equipment, Tools, and Protective Methods

Proper Use of Electrical Equipment

CONTENT OF PROGRAM

Documentation of Program

Oversight and Auditing

Technical Support

Emergency Preparedness

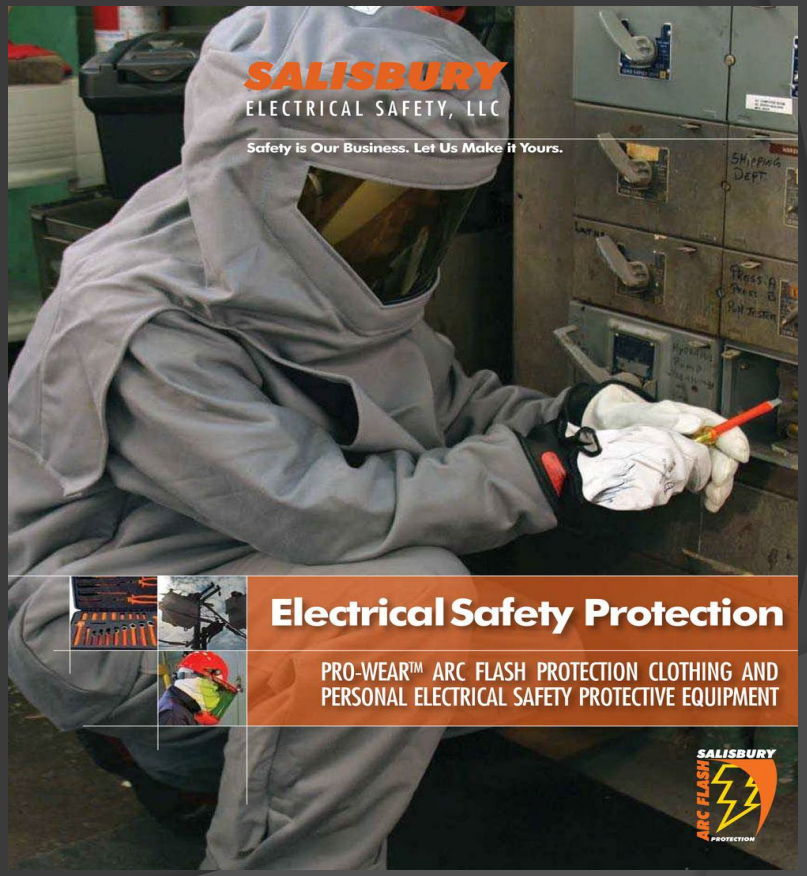
MANAGEMENT COMMITMENT

To be effective,
an Electrical Safety Program
must be strongly supported
at the highest levels of management
And, Establish A Budget

ELECTRICAL SAFETY POLICY

- Electrically safe facilities shall be established and maintained

- All work involving electrical energy shall be performed in a safe manner



ELECTRICAL SAFETY POLICY

Let’s Review and Sample Program

Purpose

The purpose of the Electrical Safety program is to set forth procedures for the safe use of electrical equipment, tools, and appliances at ABC COMPANY, INC..

Scope

This program applies to all ABC COMPANY, INC. employees, temporary employees, and contractors. When work is performed on a non-owned or operated site, the operator's program shall take precedence, however, this document covers ABC COMPANY, INC. employees and contractors and shall be used on owned premises, or when an operator's program doesn't exist or is less stringent.

Definitions

Affected Personnel - Personnel who normally use and work with electrical equipment, tools, and appliances, but who do not make repairs or perform lock out/tag out procedures.

Appliances - Electrical devices not normally associated with commercial or industrial equipment such as air conditioners, computers, printers, copiers, coffee pots, microwave ovens, toasters, etc.

Circuit Breaker - A device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined over current without injury to itself when properly applied within its rating.

Disconnecting Means - A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

Disconnecting Switch - A mechanical switching device used for isolating a circuit or equipment from a source of power.

Double Insulated Tool - Tools designed of non-conductive materials that do not require a grounded, three wire plug.

Ground - Connected to earth or some conducting body that serves in place of the earth.

Grounded Conductor - A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

Ground Fault Circuit Interrupter (GFCI) - A device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the over current protective device of the supply circuit.

Insulated - A conductor encased within material of composition and thickness that is recognized as electrical insulation.

Premises Wiring - That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of its associated hardware, fittings, and wiring devices, both permanently and temporarily installed, which extends from the load end of the service drop, or load end of the service lateral conductors to the outlet (s). Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment.

Qualified Person - One that has been trained in the repair, construction and operation of electrical equipment and the hazards involved.

Strain Relief - A mechanical device that prevents force from being transmitted to the connections or terminals of a cable or extension cord.

Class I Locations - Are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

> Class 1 Division 1 - Is a location (a) in which hazardous concentrations of flammable gases or vapors may exist under normal operating conditions; or (b) in which hazardous concentrations of such gases or vapors may exist frequently because of repairs or maintenance operations or because of leakage; or (c) in which a breakdown or faulty operation or equipment or processes might release hazardous concentrations of flammable gases or vapors, and might also cause simultaneous failure of electrical equipment.
>
> Class 1 Division 2 - Is a location (a) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquid, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in of abnormal operation of equipment or (b) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or (c) that is adjacent to a Class 1, Division 1 location, and to which hazardous concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Class II locations - Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations include the following:

> Class II, Division 1 - A Class II, Division 1 location is a location (a) in which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures; or (b) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes, or (c) in which combustible dusts of an electrically conductive nature may be present.
>
> *NOTE*: This classification may include areas of, areas where metal dusts and powders are produced or processed, and other similar locations that contain dust producing machinery and equipment (except where the equipment is dust-tight or vented to the outside).

- These areas would have combustible dust in the air, under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures.
- Combustible dusts that are electrically nonconductive include dusts produced in the handling and processing produce combustible dusts when processed or handled.
- Dusts containing magnesium or aluminum are particularly hazardous and the use of extreme caution is necessary to avoid ignition and explosion.

Class II, Division 2 - A Class II, Division 2 location is a location in which: (a) combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus; or (b) dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment, and dust accumulations resulting there from may be ignitable by abnormal operation or failure of electrical equipment or other apparatus.

NOTE: This classification includes locations where dangerous concentrations of suspended dust would not be likely but where dust accumulations might form on or in the vicinity of electric equipment. These areas may contain equipment from which appreciable quantities of dust would escape under abnormal operating conditions or be adjacent to a Class II Division 1 location, as described above, into which an explosive or ignitable concentration of dust may be put into suspension under abnormal operating conditions.

Responsibilities

Managers/Supervisor

The HSE Manager will develop electrical safety programs and procedures in accordance with OSHA requirements and/or as indicated by events and circumstances.

Operations Managers and Supervisors are responsible for ensuring that only qualified employees and or qualified contractors perform electrical repairs or installations.

Operations Managers are also responsible for ensuring all applicable electrical safety programs are implemented and maintained at their locations.

Employees are responsible to use electrical equipment, tools, and appliances according to this program, for attending required training sessions when directed to do so and to report unsafe conditions to their supervisor immediately.

Only qualified employees may work on electric circuit parts or equipment that has not been de-energized. Such employees shall be made familiar with the use of special precautionary techniques, PPE, insulating and shielding materials and insulated tools.

Safe Work Practices

Inspections

- Electrical equipment, tools, and appliances must be inspected prior to each use.
- The use of a hard fixed GFCI or a portable GFCI adapter shall be used with all portable hand tools, electric extension cords, drop lights and all 110 volt equipment.
- Faulty equipment, tools, or appliances shall be removed from service immediately and tagged "Out of Service", dated and signed by the employee applying the tag.

Repairs

- Only Qualified Personnel, who have been authorized by the department supervisor or manager, may make repairs to supply cords on electrical tools and to extension cords.
- The names of employees authorized to make repairs will be posted in the workplace.
- Only certified electricians shall be allowed to make repairs to electrical equipment and wiring systems.
- The supervisor obtaining the services of a certified electrician is responsible to verify the electrician's credentials.
- Employees shall not enter spaces containing exposed energized parts unless qualified and proper illumination exists to enable employees to work safely.
- Employees shall not wear conductive apparel such as rings, watches, jewelry, etc. (unless they are rendered non-conductive by covering, wrapping, or other insulating means) while working on or near open energized equipment this includes batteries on trucks, forklifts, phone backup systems or other such equipment.
- If employees are subject to handle long dimensional conductor objects (ducts or pipes), steps for safe work practices shall be employed to ensure the safety of workers.

Extension Cords

- Use only three-wire, grounded, extension cords and cables that conform to a hard service rating of 14 amperes or higher, and grounding of the tools or equipment being supplied.
- Only commercial or industrial rated-grounded extension cords may be used in shops and outdoors.
- Cords for use other than indoor appliances must have a rating of at least 14 amps.
- Cords must have suitable strain relief provisions at both the plug the receptacle ends.
- Work lamps (drop light) used to power electrical tools must have a 3 wire, grounded outlet, unless powering insulated tools.
- Adapters that allow three wire, grounded prongs, connected to two wire non-grounded outlets are strictly prohibited.
- Cords must have a service rating for hard or extra-hard service and have S, AJ, ST, SO, SJO, SJT, STO, or SJTO printed on the cord.
- Cords may not be run through doorways, under mats or carpets, across walkways or aisles, concealed behind walls, ceilings or floors, or run through holes in walls, or anywhere where they can become a tripping hazard.
- High current equipment or appliances should be plugged directly into a wall outlet whenever possible.
    - All extension cords shall be plugged into one of the following:
    - A GFCI outlet;

  - A GFCI built into the cord;
  - A GFCI adapter used between the wall outlet and cord plug.

- All extension cords and or electrical cords shall be inspected daily or before each use, for breaks, plug condition and ground lugs, possible internal breaks, and any other damage. If damage is found, the extension cord or electrical cord shall be remove from service and repaired or replaced.
- Extension cords shall not be used on compressor skid to operated heat tapes or any other type of equipment on a temporary basis. Heat tapes or other equipment shall be hard wired per applicable electrical codes.

Outlets

- Outlets connected to circuits with different voltages must use a design such that the attachment plugs on the circuits are not interchangeable.

Multiple Outlet Boxes

- Multiple outlet boxes must be plugged into a wall receptacle.
- Multiple outlet boxes must not be used to provide power to microwave ovens, toasters, space heaters, hot plates, coffeepots, or other high-current loads.

Double Insulated Tools

- Double insulated tools must have the factory label intact indicating the tool has been approved to be used without a three wire grounded supply cord connection.
- Double insulated tools must not be altered in any way, which would negate the factory rating.

Switches, circuit breakers, and disconnects

- All electrical equipment and tools must have an on and off switch and may not be turned on or off by plugging or unplugging the supply cord at the power outlet.
- Circuit breaker panel boxes and disconnects must be labelled with the voltage rating.
- Each breaker within a breaker panel must be labelled for the service it provides.
- Disconnect switches providing power for individual equipment must be labelled accordingly.

Ladders

- Only approved, non-conductive ladders, may be used when working near or with electrical equipment, which includes changing light bulbs.
- Ladders must be either constructed of wood, fiberglass, or have non-conductive side rails.
- Wood ladders should not be painted, which can hide defects, except with clear lacquer.
- When using ladders they shall be free from any moisture, oils, and greases.

Energized and Overhead High Voltage Power Lines & Equipment

- A minimum clearance of 10 feet from high voltage lines must be maintained when operating vehicular and mechanical equipment such as forklifts, cranes, winch trucks, and other similar equipment.
- When possible, power lines shall be de-energized and grounded or other protective measures shall be provided before work is started.
- Minimum approach distance to energized high power voltages lines for unqualified employees is 10 feet.

- Minimum approach distance for qualified employees shall be followed per 29 CFR 1910.333(c)(3)(i) Qualified – Table S5 Selection and Use of Work Practices - Approach Distances for Qualified Employees – Alternating Current).

Confined or Enclosed Work Spaces

- When an employee works in a confined or enclosed space that contains exposed energized parts, the employee shall isolate the energy source and turn off the source and lock and tag out the energy source (Only qualified electricians can work on an exposed energy source).
- Protective shields, protective barriers or insulating materials as necessary shall be provided.

Enclosures, Breaker Panels, and Distribution Rooms

- A clear working space must be maintained in the front, back and on each side of all electrical enclosures and around electrical equipment for a safe operation and to permit access for maintenance and alteration.
- A minimum two-foot working floor space in front of panels and enclosures shall be painted yellow.
- Employees may not enter spaces containing exposed energized parts unless illumination is provided that enables the employees to work safely.
- Housekeeping in distribution rooms must receive high priority to provide a safe working and walking area in front of panels and to keep combustible materials to the minimum required to perform maintenance operations.
- All enclosures and distribution rooms must have “Danger: High Voltage – Authorized Personnel Only” posted on the front panel and on entrance doors.
- Flammable materials are strictly prohibited inside distribution rooms (Boxes, rags, cleaning fluids, etc.)

Lock Out/Tag Out

- No work shall be performed on (or near enough to them for employees to be exposed due to the dangers of tools or other equipment coming into contact with the live parts) live parts and the hazards they present.
- If 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.
- Conductors and parts of electrical equipment that have been de-energized but not been locked or tagged out shall be treated as live parts.
- Per ABC COMPANY, INC. policy all electrical will be outsourced and performed only by qualified and licensed electrical contractors who are familiar with the use of special precautionary techniques, PPE, insulating and shielding materials and insulated tools. Any equipment being made ready for maintenance will be locked out using ABC COMPANY, INC.’s Control of Hazardous Energy – Lock Out/Tag Out Program. Lockouts are performed by the HSE Manager, Shop Foreman or Branch Manager. Designated employees in some branches may be trained by local management to lock out equipment. If live sources are to be worked it will only be performed with the knowledge of local management. Only certified electricians may work on electric circuit parts or equipment.
- Only authorized personnel may perform lock out/tag out work on electrical equipment and will follow ABC COMPANY, INC.’s Control of Hazardous Energy – Lock out/Tag Out Program.
- Authorized personnel will be trained in lock out/tag out procedures.
- Affected personnel will be notified when lock out/tag out activities are being performed in their work area.

Contractors

- Only approved, certified, electrical contractors may perform construction and service work on ABC COMPANY, INC. or client property.
- It is the Manager/Supervisors responsibility to verify the contractor's certification.

Fire Extinguishers

- Approved fire extinguishers must be provided near electrical breaker panels and distribution centers.
- Water type extinguishers shall not be located closer than 50 feet from electrical equipment.

Electric Shock-CPR:

- If someone is discovered that has received an electric shock and is unconscious, first check to see if their body is in contact with an electrical circuit. Do not touch a person until you are sure there is no contact with an electrical circuit.
- When it is safe to make contact with the victim, begin CPR if the person's heart has stopped or they are not breathing.
- Call for help immediately.

Electric Welders

- A disconnecting means shall be provided in the supply circuit for each motor-generator arc welder, and for each AC transformer and DC rectifier arc welder which is not equipped with a disconnect mounted as an integral part of the welder.
- A switch or circuit breaker shall be provided by which each resistance welder and its control equipment can be isolated from the supply circuit. The ampere rating of this disconnecting means may not be less than the supply conductor ampacity.

Equipment Grounding

- All gas compressors, air compressors, separators, vessels, etc. shall be grounded by means of using a lug and ground strap, nominal in size to a ½" bolt or larger, attached to a ground rod six feet or longer.
- Equipment bonding jumpers shall be of copper or other corrosion-resistance material.
- The transfer of hazardous or flammable material from a metal or plastic container with a flash point of 100 degrees F or less shall have a ground strap from the container and attached to the skid or a ground rod placed in the ground.

Training

All regular full time and temporary employees will be trained in Electrical Safety utilizing the ABC COMPANY, INC. Electrical Safety Training course or an approved equivalent.

Employees who face a risk of electric shock, but who are not qualified persons, shall be trained and familiar with electrically related safety practices.

Employee shall be trained in safety related work practices that pertain to their respective job assignments.

Employees shall be trained on clearance distances.

SAFE WORK PRACTICES

SAFEST BASIC RULE

Work on or near exposed live parts should be prohibited, except under justified, controlled, and approved circumstances.

SAFE WORK PRACTICES

- Avoid work on energized electrical equipment
- Requiring work authorization
- Familiarity with recognized safe work practice standards
- Written safe practices and procedures

SAFE WORK PRACTICES

- Safety training and qualifications
- Safety audits and self-assessments of personnel activities
- Use of oversight groups
- A technical authority to respond to questions regarding safe work practices

(See Chapter 10 of Yellow Book)

TRAINING AND QUALIFICATION OF ALL PERSONNEL

All personnel should have training appropriate to their tasks.

- Qualified persons need training on construction and operation of specific equipment, and the hazards involved. See definition of Qualified Person from NFPA 70E.

- Others need training in basic electrical safety awareness.

TRAINING AND QUALIFICATION OF ALL PERSONNEL

Remember:

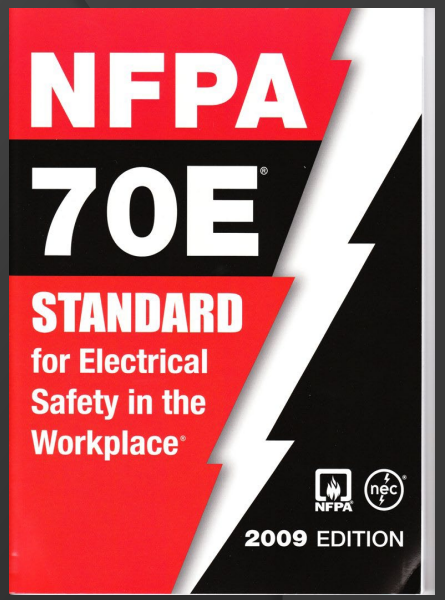
Training must be commensurate with the exposure

EMERGENCY PREPAREDNESS

- All Electrical Workers should know first aid and CPR. See NFPA 70E, Section 110.6(C)

- Emergency Responders should know basic electrical safety awareness, care for electrical accident victims, and self-protective

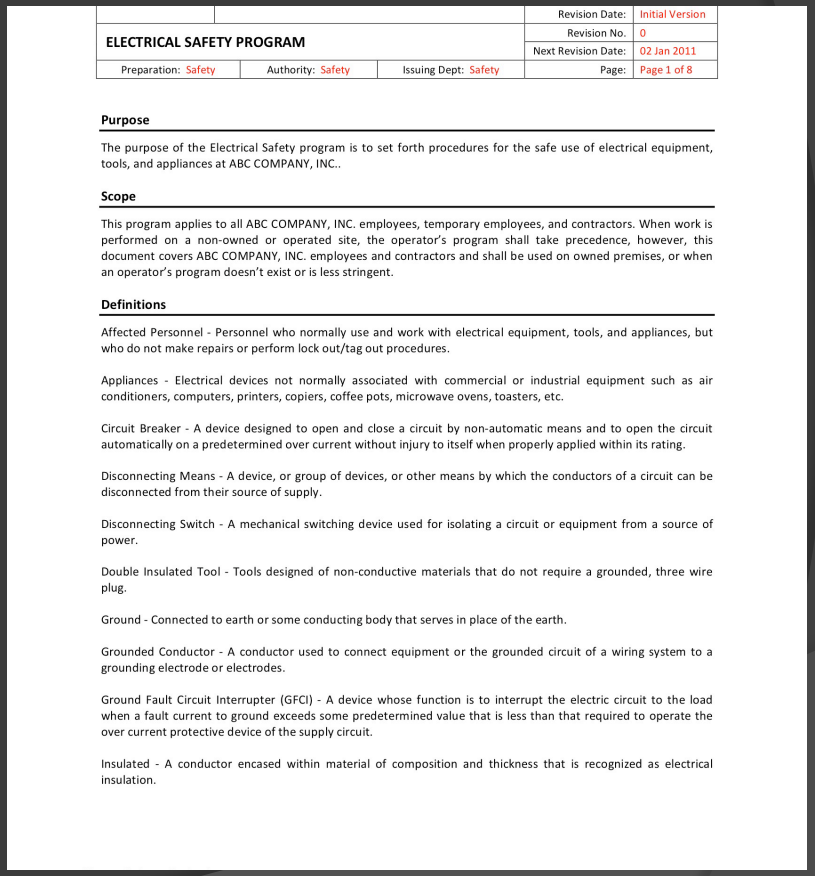
NFPA 70E & OSHA HOW TO CITE ELECTRICAL HAZARDS



NCDOL
N.C. Department of Labor
Commissioner

OSHA Electrical Hazards Citations

- **Electrical safe work practices program** – both NFPA and OSHA agree that employers shall develop effective electrical safe work practices program and procedures. These procedures include the areas such as found in the attached sample "electrical safe work practices program".
- Possible Citations
- **29CFR1910.333**
  29CFR1910.303(b)



			Revision Date:	Initial Version
ELECTRICAL SAFETY PROGRAM			Revision No.	0
			Next Revision Date:	02 Jan 2011
Preparation: Safety	Authority: Safety	Issuing Dept: Safety	Page:	Page 1 of 8

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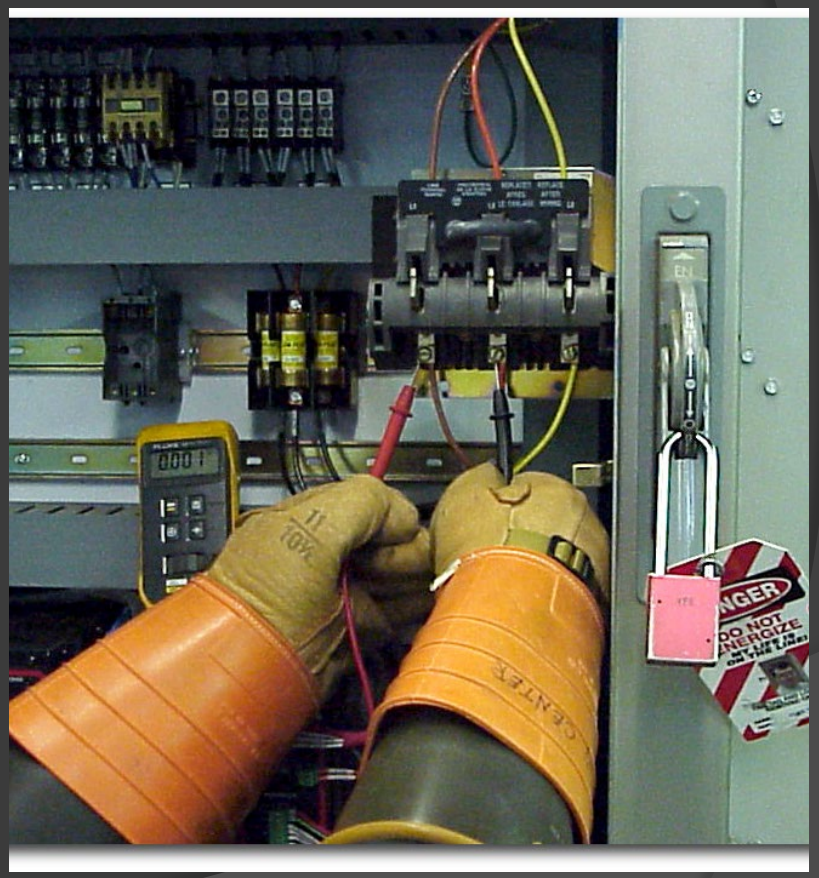
Insulated - A conductor encased within material of composition and thickness that is recognized as electrical insulation.

OSHA Electrical Hazards Citations

- **Hazard Assessment** – Under the PPE standard, OSHA expects employers to perform PPE hazard assessments to determine necessary PPE for protection of workers from electrical hazards. In a 2008 letter of interpretation, OSHA recognized the existence of NFPA 70E without reference to the version of the standard. OSHA also directed employers to utilize the tables C(9), C(10) and C(11) in the NFPA standard as tools to perform the hazard assessment and select the necessary PPE.
- Citations:
- **29CFR1910.132(d)(1)**
  29CFR1910.303(b)
  Ref: NFPA 70E Article 130.7 C(9), C(10) and C(11)



OSHA Electrical Hazards Citations

- **Arc Flash Protection Clothing & Eye Protection** – Based on the employer's hazard assessment, employees exposed to electrical hazards must be protected.
- Citations:
- **29CFR1910.335(A)(1) Ref: NFPA 70E Article 130.7 C(10) and C(11)**

OSHA Electrical Hazards Citations

- **Tools listed and labeled.** OSHA expects that all tools that are used for electrical work be listed and labeled and used in accordance with the manufacturer's instructions. This would include hand tools, electrical cables and cords, non-insulated tools, insulated tools, meters and other testing devices.
- Citation
- **29CFR1910.303(a)**

OSHA Electrical Hazards Citations

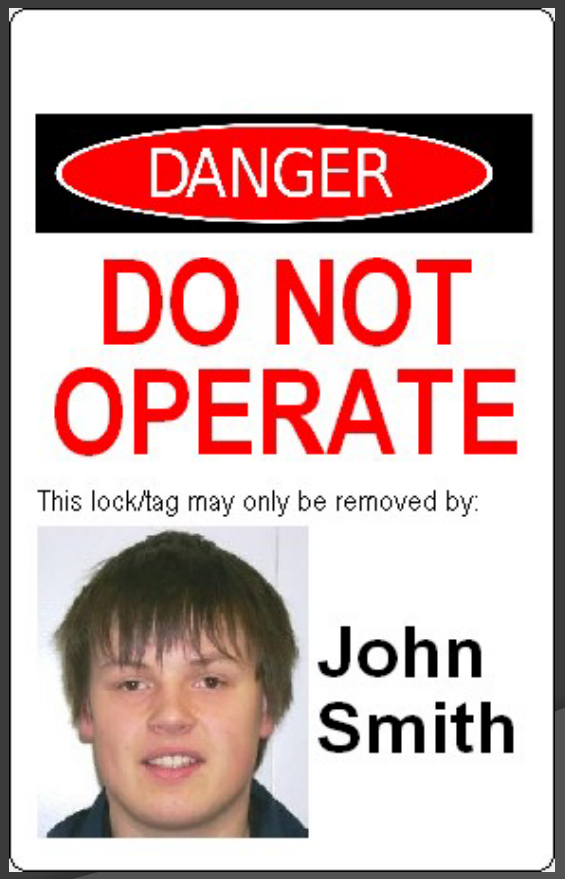
- **Electrical Marking** OSHA requires that equipment be marked including: Other markings giving voltage current, wattage, or other ratings as necessary.
- **Citation**
- **29CFR1910.303(3)(1)(ii)**

OSHA Electrical Hazards Citations

- **Electrical Inspection of Equipment.** OSHA requires examination of equipment. Electric equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined using the following considerations: Arcing effects
- **Citation**
- **29CFR1910.303(b)(1)(vi)**

OSHA Electrical Hazards Citations

- **Lockout Tagout** – Both OSHA and NFPA agree that equipment should be de-energized and lockout tagout procedures followed prior to working on equipment. NFPA uses the language of feasible vs. convenient. NFPA only allows equipment to worked “hot” if de-energizing is not feasible.
- Citation
- **29CFR1910.147(c)(7)(i)**
  Ref: NFPA 70E Article 120

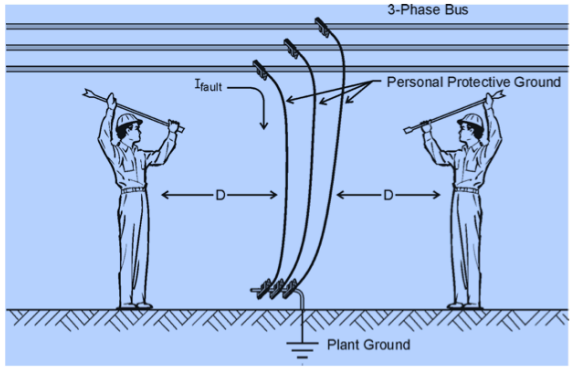


OSHA Electrical Hazards Citations

- **Training** – Employees exposed to electrical hazards must be qualified and trained. Both OSHA and NFPA require qualification training for employees exposed to electrical hazards. **29CFR1910.332.(b)(3)**

Temporary Grounding for Personnel

Personal Protective Grounding for Electric Power Facilities and Power Lines



NFPA 70E – Temporary Protective Grounding Equipment

- 120.3 (A) Placement. Temporary protective grounds shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to hazardous differences in electrical potential.

NFPA 70E – Temporary Protective Grounding Equipment

- If Procedures are not followed, worker can become part of the path to ground
- Must have a Proper Ground
  - Grounding in Earth
  - Grounding Connection Straps
  - Grounding Connections
- Must Have an Impendence Match & Proper Ampacity
- Must Wear all Necessary Shock Hazard PPE

Temporary Grounding

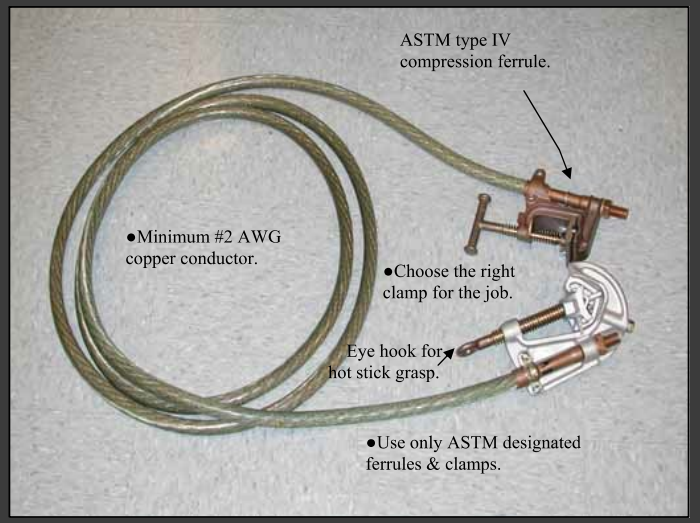


Figure 2. – Personal Protective Ground Cable Assembly.

5.1.1 Cable Ampacity. Grounding cable must be sized adequately to carry the maximum available fault current at the worksite as required in paragraph 4.2. In many cases not all electrical equipment which can contribute fault current is in service or it can be put into a condition that it cannot contribute current. Check the methods in paragraph 6.1 for determining available fault current to avoid unnecessary large ground cable.

Ground cables shall be sized in accordance with the fault current withstand ratings given in tables 2A and 2B. Withstand ratings are approximately 70 percent of the ultimate (melting) current capacity of new copper conductor. This provides a margin of safety to prevent in-service failure and to allow the ground cable to be reused after being subjected to fault current. Use table 2A if

NFPA 70E 2012
WHAT'S COMING

Update: What's Coming in NFPA 70E 2012

Throughout the Document

- Flame Resistive Clothing (FR) will change to Arc Rated Clothing (AR) Throughout the document

Article 90 Revision

- This section now uses a very important word: "inspection." Electrical inspectors also can be exposed to hazards during inspections of installations, and this standard will now cover them

Update: What's Coming in NFPA 70E 2012

Article 100 Definitions Revision

- The 2012 edition will feature a new informational note added to the existing arc flash hazard analysis definition. It defines the term "incident energy analysis" as "a method used to predict the incident energy of an arc flash for a specified set of conditions."
- Previous editions referred to the arc flash protection boundary. The 2012 edition will use the term "arc flash boundary" (AFB). The word "protection" has been deleted

Update: What's Coming in NFPA 70E 2012

Article 110 Safe Work Practices Revision

- This section is new to the code and will require a documented meeting between the host employer and contract employer.
- The 2012 edition will require the use of an automatic external defibrillator (AED) in addition to the existing requirement of training and employer certification of cardiopulmonary resuscitation (CPR).

Update: What's Coming in NFPA 70E 2012

Article 110 Safe Work Practices Revision

- "The employer shall determine through regular supervision and through inspections conducted on at least an annual basis that each employee is complying with the safety-related work practices required by this standard." This mirrors similar language in OSHA 29 CFR 1910.269(a)(2)(iii).

Update: What's Coming in NFPA 70E 2012

Article 110 Safe Work Practices Revision

- The 2012 edition will require all employees to be retrained at intervals not to exceed three years
- Language will be added that requires training content documentation in addition to the section's existing requirements.
- The 2012 edition will incorporate language to include working within the AFB in addition to the existing requirement for working within the limited approach boundary (LAB). It is possible that the AFB could be greater than the LAB and vice versa.

Update: What's Coming in NFPA 70E 2012

Article 120 Safe Work Practices Revision

- The 2012 edition will remove individual employee control as one of three forms of control of hazardous electrical energy, leaving the two methods: simple and complex lockout/tagout.

Update: What's Coming in NFPA 70E 2012

Article 130 Work Involving Electrical Hazards Revision

- "All requirements of this article shall apply whether an incident energy analysis is completed or if the tables 130.7(C)(9) and (C)(10) are utilized in lieu of incident energy analysis." The new language is intended to help clarify that, when the table method is used, the other requirements of this section, such as providing proper justification and completing the energized work permit, still apply.

Update: What's Coming in NFPA 70E 2012

Article 130 Work Involving Electrical Hazards Revision

- The 2009 edition requires that energized conductors or circuit parts be placed into an electrically safe working condition before an employee works within the LAB. New language expands this requirement to apply if any of the following conditions exist:• The employee is within the LAB (same as before)• The employee is within the AFB• The employee interacts with equipment where conductors or circuit parts are not exposed, but an increased risk of arc flash hazard exists• An informational note is added that refers to the definition of "arc flash hazard" in Article 100.

Update: What's Coming in NFPA 70E 2012

Article 130 Work Involving Electrical Hazards Revision

- "When working within the limited approach boundary or the arc flash boundary of exposed energized electrical parts … ." This language is intended to help clarify when the code requires an energized work permit
- The 2012 edition will feature a renumbered version of this table as Table 130.2(C)(1), and it will specifically apply to alternating current (AC) power systems. A new table, 130.2(C)(2) will apply to direct current (DC) power systems.

Update: What's Coming in NFPA 70E 2012

Article 130 Work Involving Electrical Hazards Revision

- an arc flash hazard analysis may not be necessary for some three-phase systems rated less than 240V. It will then reference the IEEE standard for more information.
- The 2012 edition will not feature the "four foot rule" in this section, and there will no longer be separate sections for the AFB at voltage levels between 50V and 600V and voltage levels above 600V. The revised language will state that the AFB for systems 50V and greater shall be the distance at which the incident energy is 1.2 calories per square centimeter. Instead of the "four foot rule," AFB will be located in Table 130.7(C)(9).

Update: What's Coming in NFPA 70E 2012

Article 130 Work Involving Electrical Hazards Revision

- . Electrical equipment—such as switchboards, panel boards, industrial control panels, meter socket enclosures and motor control centers—and that are likely to require examination, adjustment, servicing or maintenance while energized, shall be field-marked with a label containing all of the following information:(1) Only one of the following:a. Available incident energyb. Minimum arc rating of clothing(2) Date of arc flash hazard analysis(3) Nominal system voltage(4) Equipment identification(5) Arc flash boundary

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Article 130 Work Involving Electrical Hazards Revision

- Employees shall wear hearing protection whenever working within the AFB

Short Circuit and Clearing Times (New)

- The maximum short-circuit current and clearing times that previous editions listed in the table's footnotes will be relocated within the appropriate sections of the table. This will help ensure users are aware of the appropriate limits.

Arc Flash Protection Boundaries (New)

- A new column will list the AFB for each task. This addition coincides with the deletion of the "four foot rule" from 130.3(A).

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Article 130 Work Involving Electrical Hazards Revision

DC Hazard/Risk Tables (New)

- Table 130.7(C)(9) will be renumbered as Table 130.7(C)(9)(1). A new table 130.7(C)(9)(2) will feature specifications for hazard/risk categories for DC systems.

Category 2* Deleted (Revision)

- The 2012 edition will feature all references to hazard/risk category 2* in Table 130.7(C)(9) changed to HRC 2 based on the information below.

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- Category 2 will require a balaclava sock or an arc flash suit hood. There was an inconsistency with Section 130.7(C)(1), which required all parts of the body inside the AFB to be protected.
- Additional language will state: "When the incident energy exposure is greater than 12 cal/cm2, a suitably rated arc flash suit hood shall be used."
- The 2012 edition will feature new language in this section, requiring face shields with a wraparound guarding to protect the face, chin, forehead, ears and neck to be used.

NFPA 70E ELECTRICAL SAFETY KEY PRINCIPLES

ELECTRICAL SAFETY PRINCIPLES

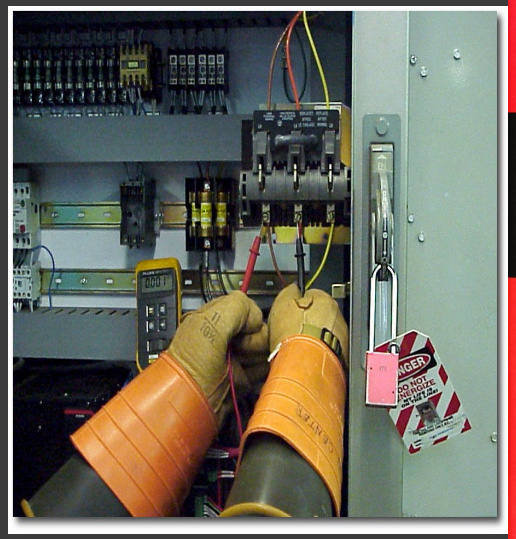
It's Just 40 Little Words

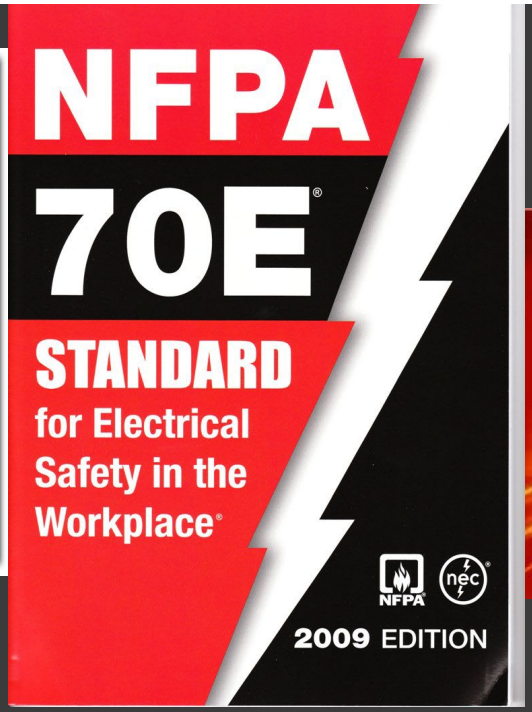
Plan Every Job
Anticipate Unexpected Events
Identify the Hazard
Minimize the Hazard
Use Procedures as Tools
Use the Correct Tools for the Job Task
Use Personal Protective Equipment
Isolate the Equipment
Assess People's Abilities
Protect the Person
Audit these Principles

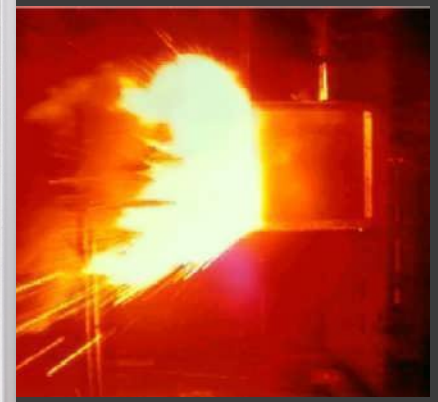
Resources

- www.nfpa.org
- www.oshainfo.gatech.edu
- http://www.ies.ncsu.edu/solutions/affiliated-programs/OTIEducationCenter/
- http://www.ieee.org/index.html
- http://www.salisburybyhoneywell.com/
- http://www.walls.com/flame-resistant

NCDOL
N.C. Department of Labor







NFPA 70E Electrical Safety, Arc Flash/Blast