Water Environment Association of Texas

ARC FLASH SAFETY TRAINING

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Pertinent Laws, Rules, Codes & Standards

- Occupational Safety and Health Administration (OSHA)
  - 29 CFR Part 1910, Subpart S – February 14, 2007
  - References Significant Portions of NFPA 70E
- National Fire Protection Association
  - NFPA 70 – 2017 National Electrical Code (NEC)
  - NFPA 70E – 2018 Standard for Electrical Safety in the Workplace

- Arc Flash Awareness Training is be consistent with the OSHA Standards “Subpart S” Electrical and the 2018 NFPA 70-e requirements for employees who may potentially be exposed to Electrical and Arc Flash Hazards.

- Training should provide instruction on safe work practices on how to avoid contact with energized electrical parts, and Arc Flash Avoidance.

- Electrical Safety goes hand-in hand with Lockout/Tagout (LOTO) and is an integral part of the Arc Flash and Electrical Safety Programs.

- LOTO, the control of hazardous energy is an approved method in isolating hazards that must be controlled during the repair and replacement of equipment.

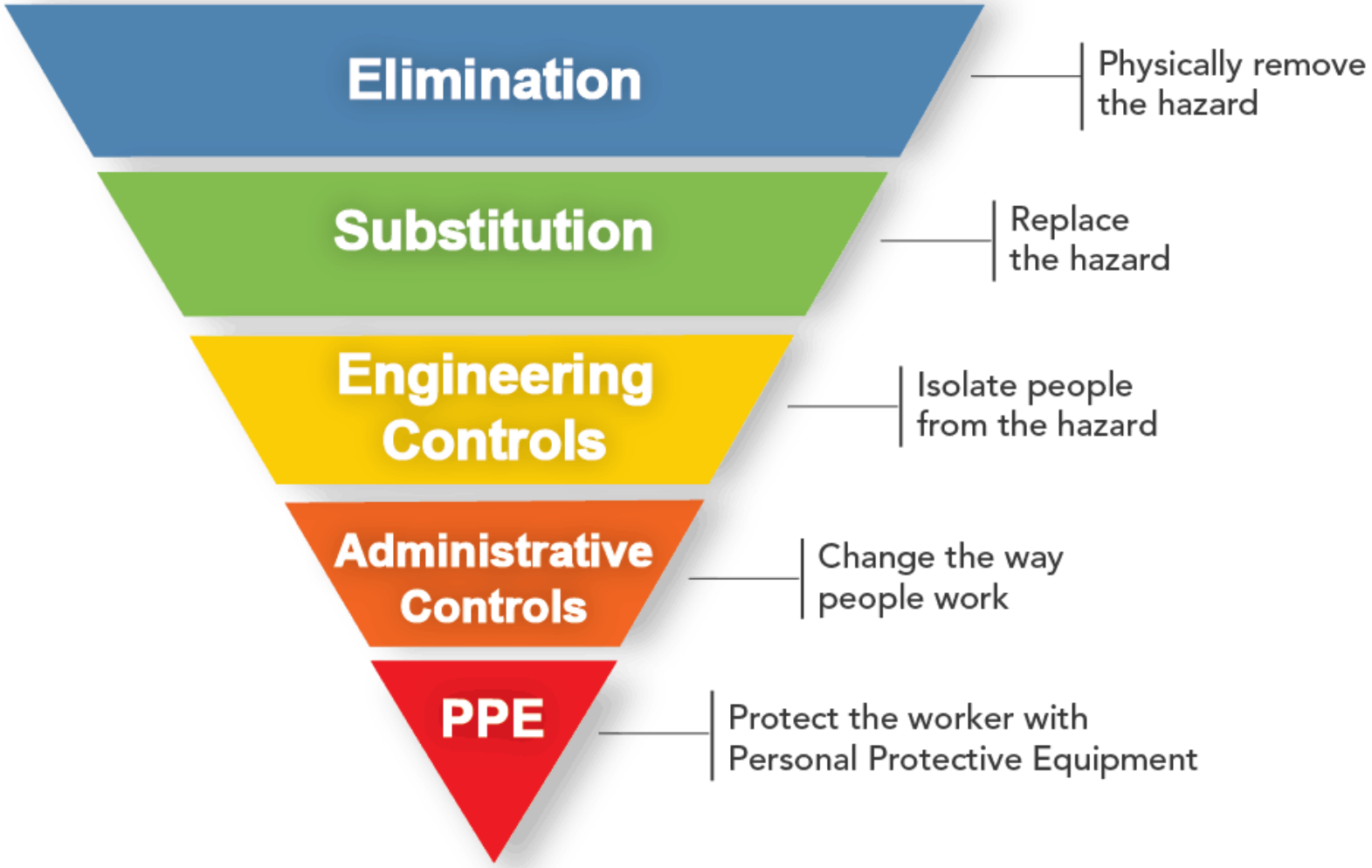
Course Goals and Objectives:

- Identify Arc Flash Hazards
- Understand Arc Flash Boundaries,
- Understand Warning Labels:
  - Arc Flash Hazard Ratings
  - Arc Flash Boundaries
  - Safe Approach Distances

Hierarchy of Controls

- Eliminate – physically remove the hazard
- Substitute – replace the hazard
- Engineering – isolate people from the hazard
- Administration – Signage, Labels and Changes to the way people work
- PPE – protective clothing

Hierarchy of Controls



2018 Changes to NFPA-70e

Risk Assessment Procedure — The risk assessment procedure now specifically requires you to address human error and its negative consequences on people, processes, work environments, and equipment.

Hierarchy of Risk Control Methods — Formerly part of an informational note, the hierarchy of risk control methods has moved into the standard's mandatory text.

Establishing an Electrically Safe Work Condition (ESWC) — Although there are no major changes to these requirements, the sections within Article 120 have been completely restructured to logically step you through how to set up a program. „

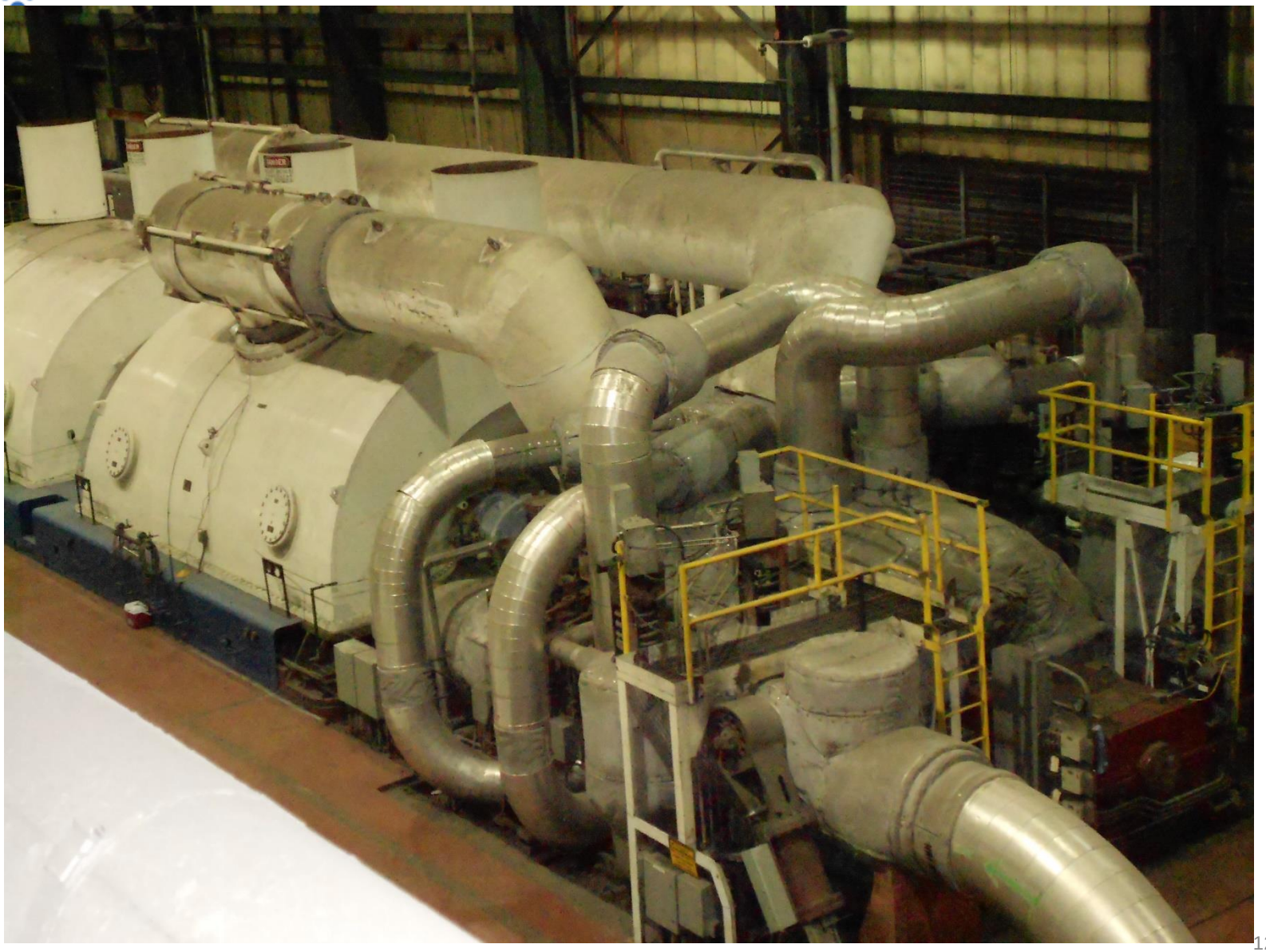
2018 Changes to NFPA-70e

Estimate of the Likelihood of Occurrence of an Arc Flash Incident — This table has been revised and has also moved [now Table 130.5(C)]. This table can be used for both ways of doing your arc flash risk assessment — it now also applies to the incident energy analysis method, instead of just the PPE category method. „

Selection of Arc-Rated Clothing using Incident Energy Analysis Method — Formerly part of the Annex material, this table [now Table 130.5(G)] has moved into the standard's mandatory text.

Where Does Electricity Come From?

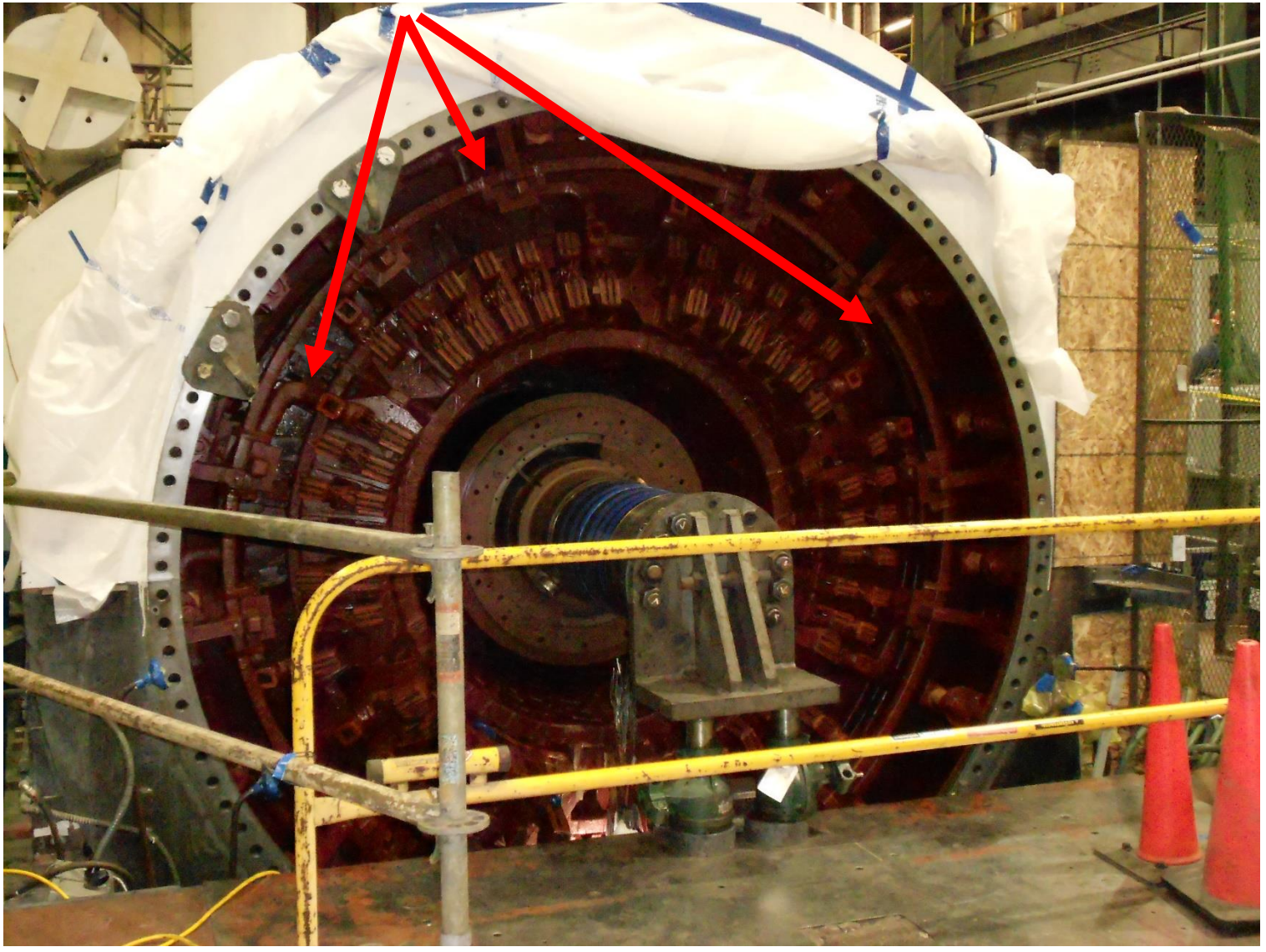
Electricity is produced by spinning a magnet inside a coil of wire



Steam turns a Turbine – mechanical energy

Generator Coils – electrical energy

3 Phase

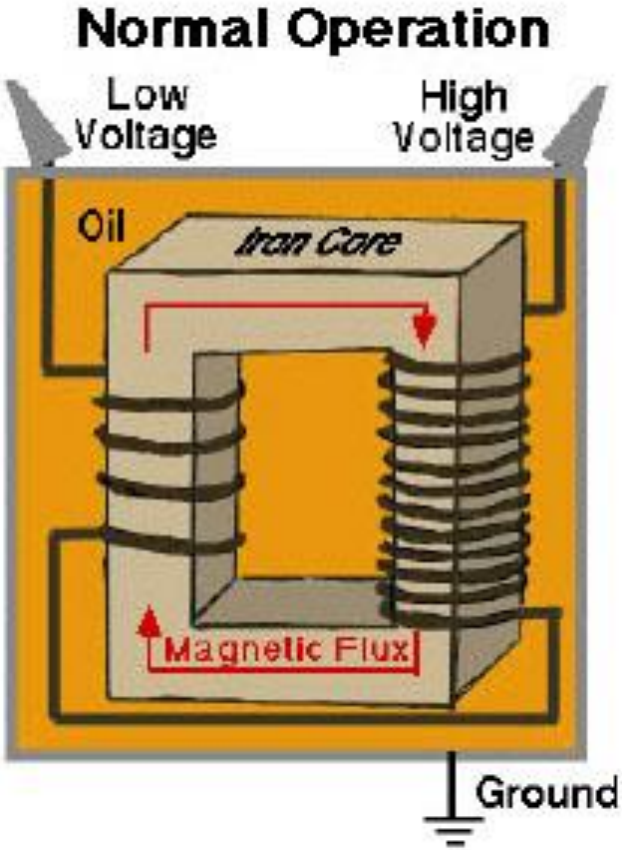


The generator produces electricity & an electrical distribution system delivers it to your home, office, and factory.

Water Enviro

Water

Transformers convert high voltage electricity into usable voltages




FORTU

Primary Hazards Associated with Electricity

- Electrocution (death due to electrical shock)
- Electrical shock
- Burns
- Fires
- And other injuries resulting from an electrical shock, typically falls

Electrocution

- Currents no greater than 75 mA* 75 /1000

- Can cause ventricular fibrillation (rapid, ineffective heartbeat)

- Will cause death in a few minutes

• Electrical Shock occurs when current passes through the body.

•Severity of the shock depends on:

- **Path** of current through the body
- **Amount of current** flowing through the body
- **Length of time** the body is in the circuit

•The muscular structure of the body is also a factor.

-people with more body fat typically have less effects.

LOW VOLTAGE DOES NOT MEAN LOW HAZARD

If A Worker is Electrocuted:

- Call 911 immediately
- Shut off the current
- Never touch an energized person with your bare hands

- If the person's heart is not beating:
  - Perform CPR
  - Keep the person lying down
  - Keep the person warm
  - REASSURE the person

ARC BLAST - FIRES

•Arc-blasts occur from high-amperage currents arcing through air. This abnormal current flow (arc-blast) can reach temperatures of 39,000 degrees F.

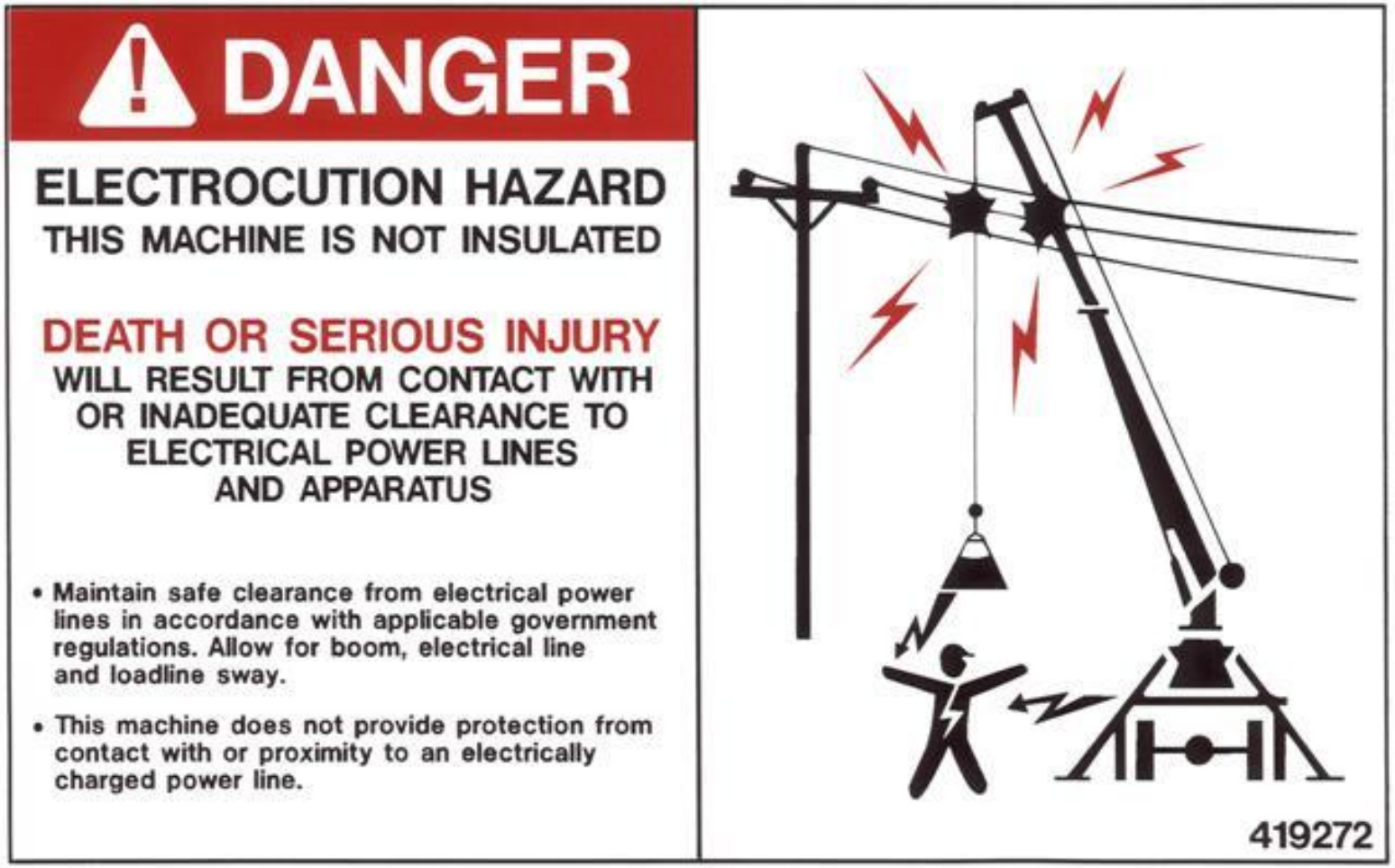
•The temperature of the sun is 9,000 to 10,000 degrees F

ARC BLAST EXPLOSIONS

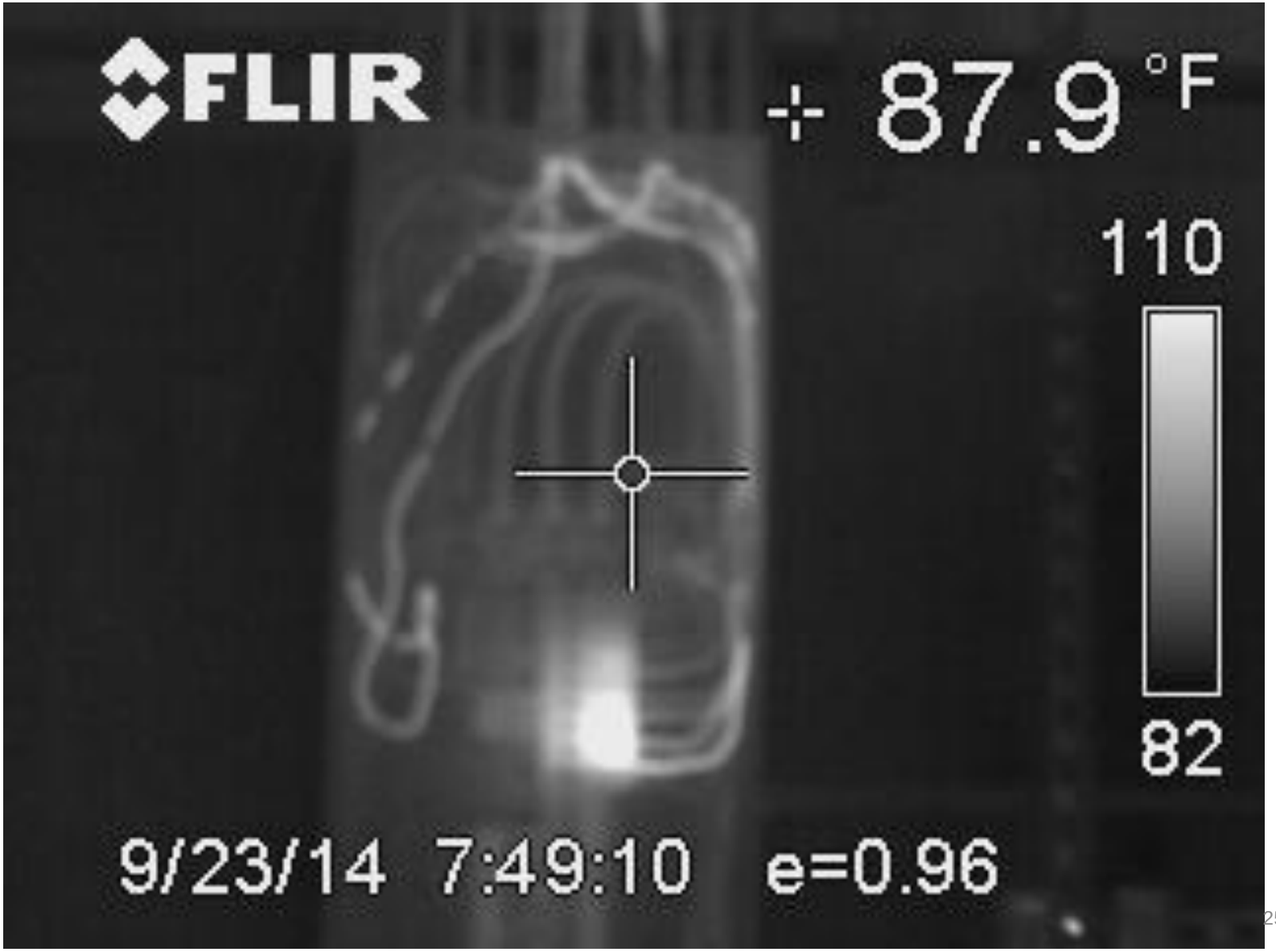
Explosions can be caused by:

- Overheated conductors
- Equipment failure
- Arcing at switch contacts
- Human error

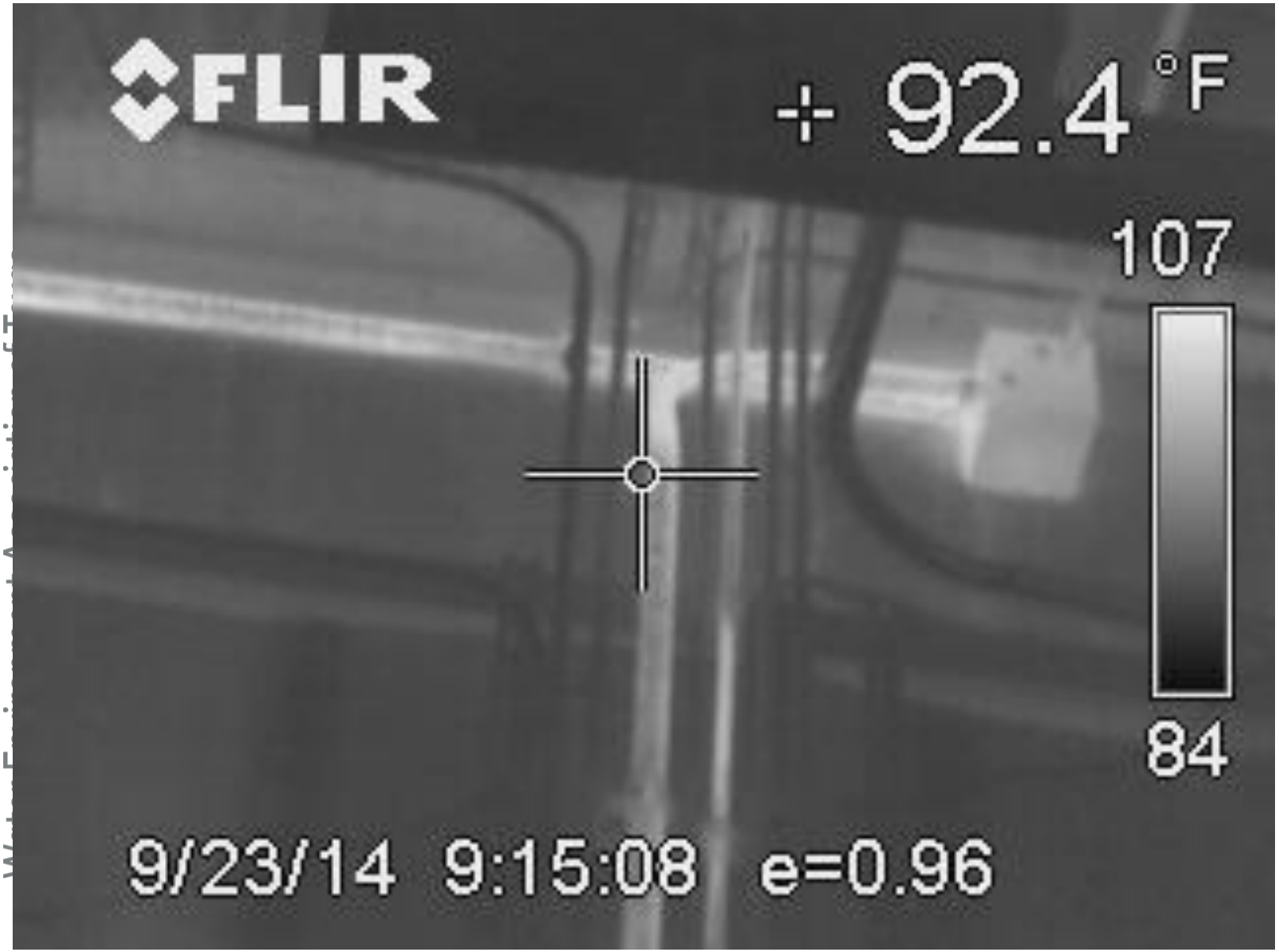
Electric Shock Protection
Avoidance



Thermal Imaging – Overloaded Circuit



Thermal Imaging – Overloaded Wiring



- Working with Energized Equipment
- Safe Work Procedures
- Qualified Persons

Working on Live Circuits

*Qualified workers **shall not** be asked to work on "hot" or "live" except :*

1. *Deenergizing equipment – removing fuses, troubleshooting, etc.*

2. *Infeasible due to equipment design or operational limitations - voltage testing, bump motor for rotation, start up testing, etc.*

Protective Clothing

- Electric arcs produce the highest temperatures on earth –up to 39,000 degrees Fahrenheit, 4 x temp of the sun!
- The intense heat from arc causes the sudden expansion of air that results in a blast with very strong air pressure (Lightning is a natural arc).
- All known materials are vaporized at this temperature. (**Copper expands 67,000 times its volume**, Water expands to steam at a rate of 1670 times).

Hazard Risk Categories(HRC)

- HRC O: Single Phase circuit operating at 50-208 volts
- HRC 1&2: Three Phase circuit operating between 120 and 600 volts
- HRC 3&4 Three-Phase service entrance equipment and Switchgear operating between 120 to 600 volts including those systems with RED level V Arc Flash Hazard Labels

NFPA -70E

- Protective Clothing

4 cal/cm^2	Arc-rated long-sleeve shirt Arc-rated pants or coverall Arc-rated face shield with hard hat Safety glasses Hearing protection Leather & voltage-rated gloves (as needed) Leather footwear	

8 cal/cm²

Arc-rated long-sleeve shirt

Arc-rated pants or coverall

Arc-rated face shield & balaclava or arc flash suit hood with hard hat

Safety glasses, Hearing protection

Leather & voltage-rated gloves (as needed)

Leather footwear

25 cal/cm^2	Arc-rated long-sleeve jacket Arc-rated pants Arc-rated flash hood with hard hat Safety glasses, Hearing protection Leather & voltage-rated gloves (as needed) Leather footwear	
40 cal/cm^2	Arc-rated long-sleeve jacket Arc-rated pants Arc-rated flash hood with hard hat Safety glasses, Hearing protection Leather & voltage-rated gloves (as needed) Leather footwear	

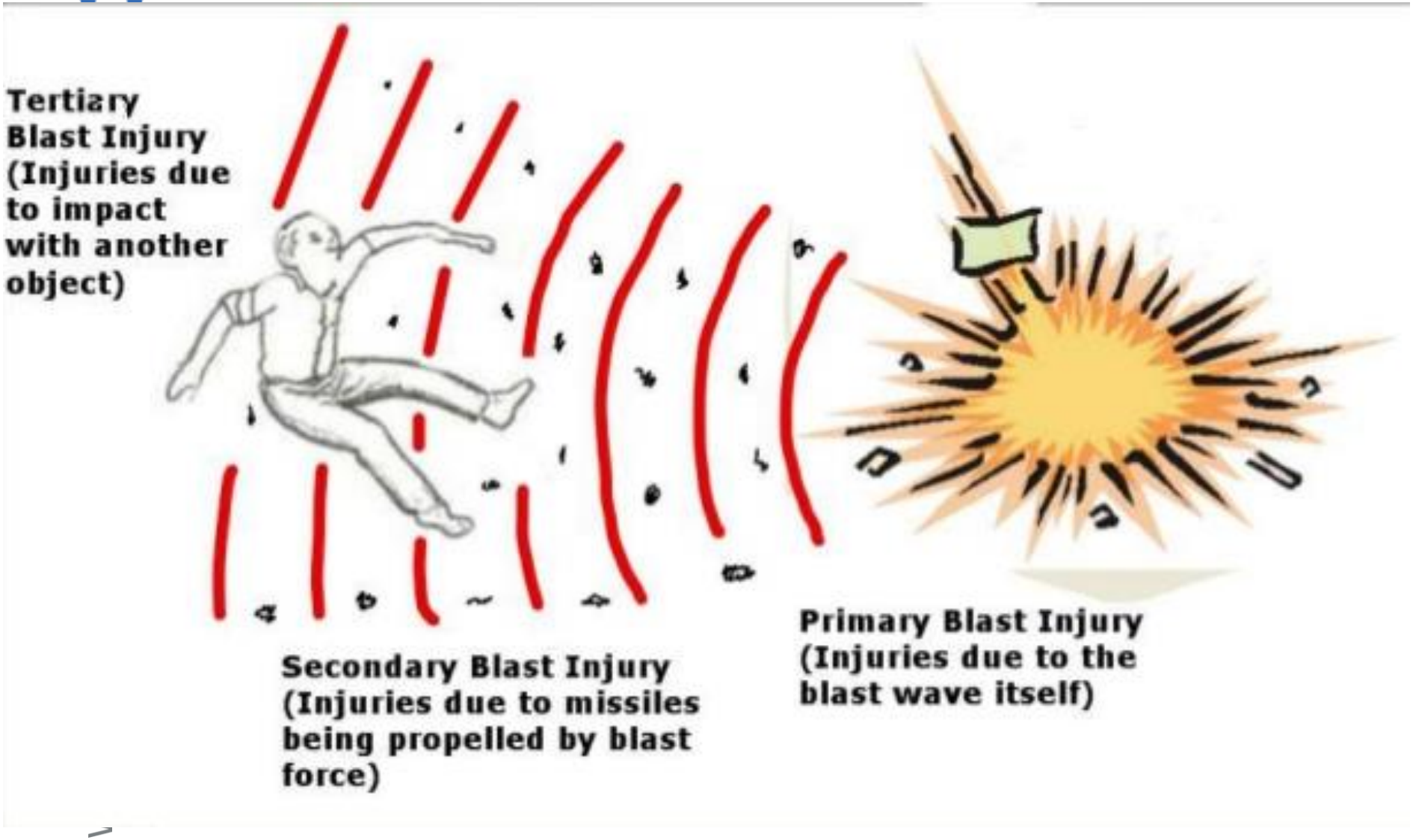
Water En

Protective Clothing

Clothing can be ignited several feet away. Clothed areas can be burned more severely than exposed skin.

- Hearing loss from sound blast. The sound can have a magnitude as high as 140 dB at a distance of 2 feet from the arc.

- Energy released is a function of:
  - System voltage
  - Fault current magnitude
  - Fault duration


Tertiary Blast Injury (Injuries due to impact with another object)
Secondary Blast Injury (Injuries due to missiles being propelled by blast force)
Primary Blast Injury (Injuries due to the blast wave itself)

How to Protect against Shock and Arc Flash/Blast?

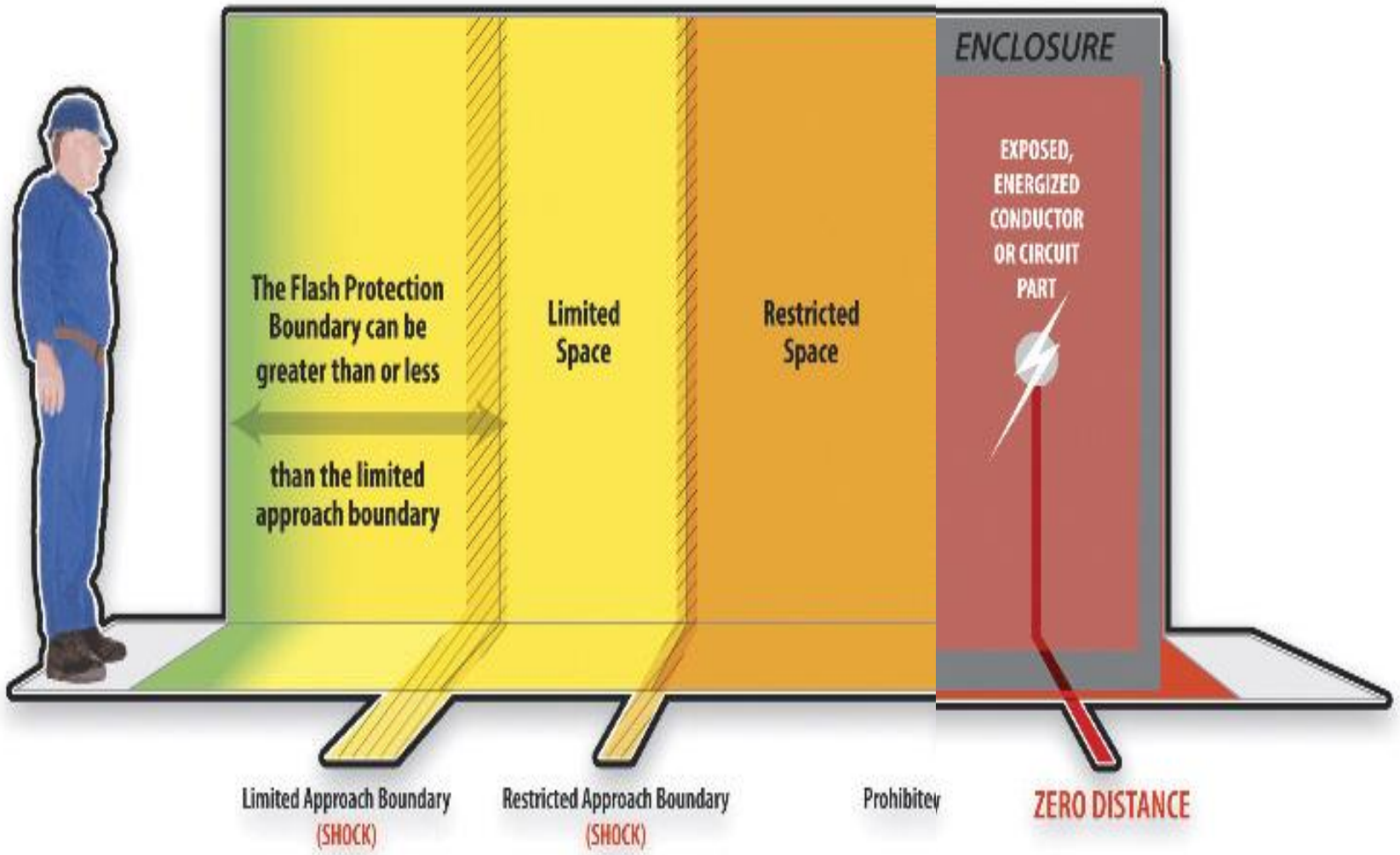
1. Justification for Live Work – Only when there is NO other means to accomplish the job. Have Live Work Permits and Secure the area.

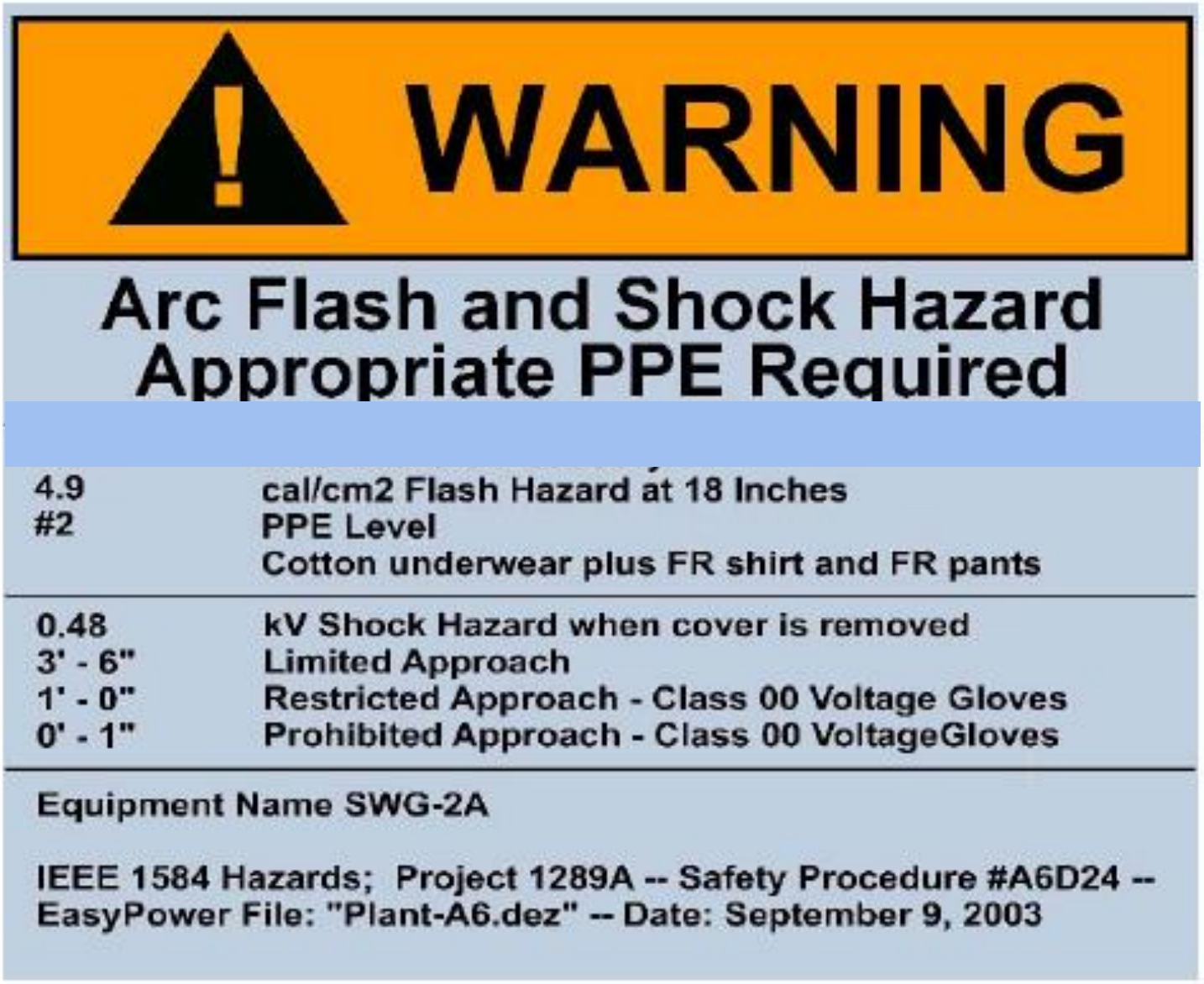
2. Establish Safe Approach Boundaries
   - Flash Protection Boundary
   - Limited Boundary
   - Restricted Boundary
   - Prohibited Boundary

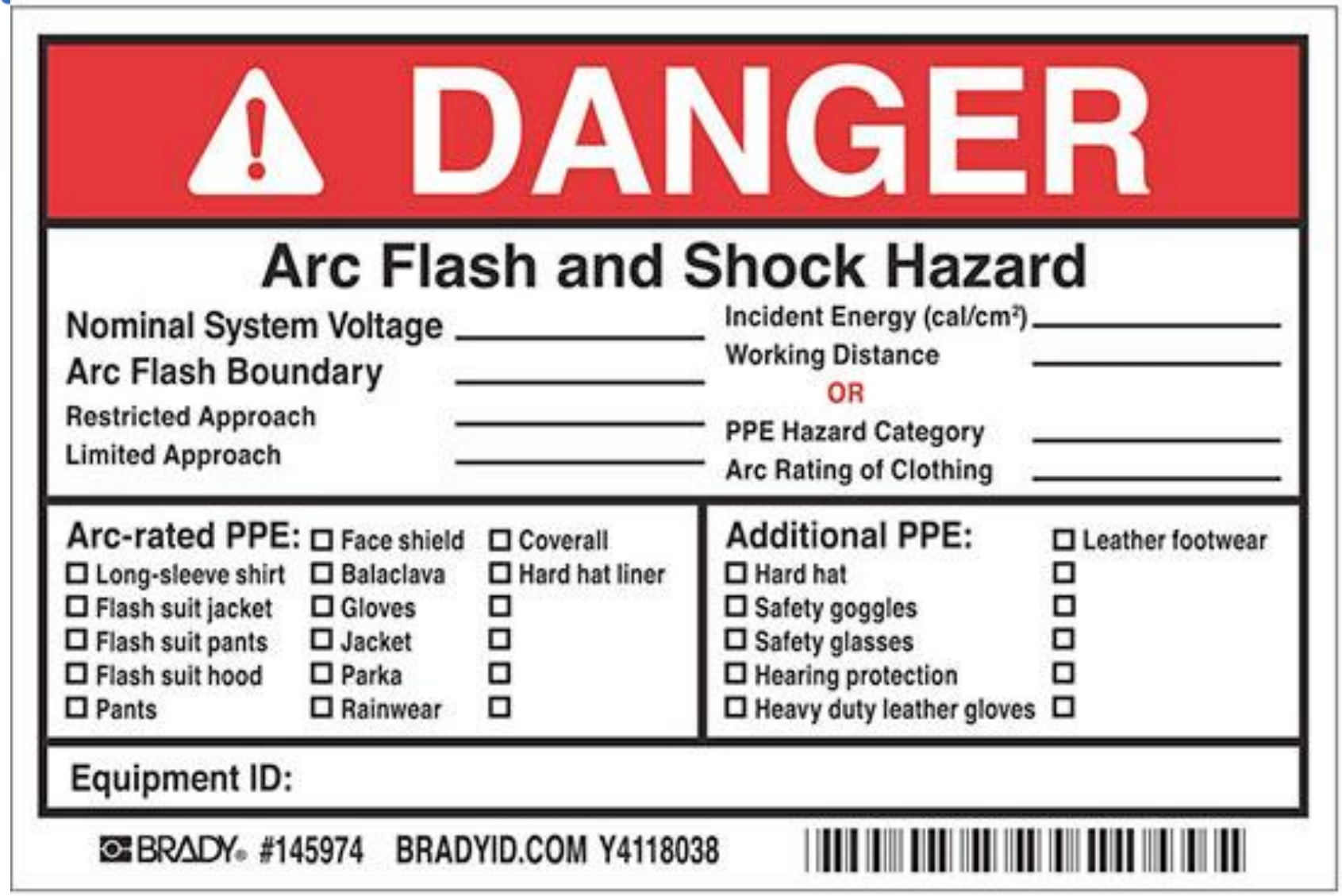
- **Flash Protection Boundary-** linear distance to prevent any more than 2nd degree burns from a potential arc-flash (Typically 3 to 4 feet)

- **Limited Approach Boundary -** entered only by qualified persons or unqualified persons that have been advised and are escorted by a qualified person

- **Restricted Approach Boundary -** entered only by qualified persons required to use shock protection techniques and PPE


ENCLOSURE
EXPOSED, ENERGIZED CONDUCTOR OR CIRCUIT PART
The Flash Protection Boundary can be greater than or less
than the limited approach boundary
Limited Space
Restricted Space
Limited Approach Boundary
(SHOCK)
Restricted Approach Boundary
(SHOCK)
Prohibitev
ZERO DISTANCE

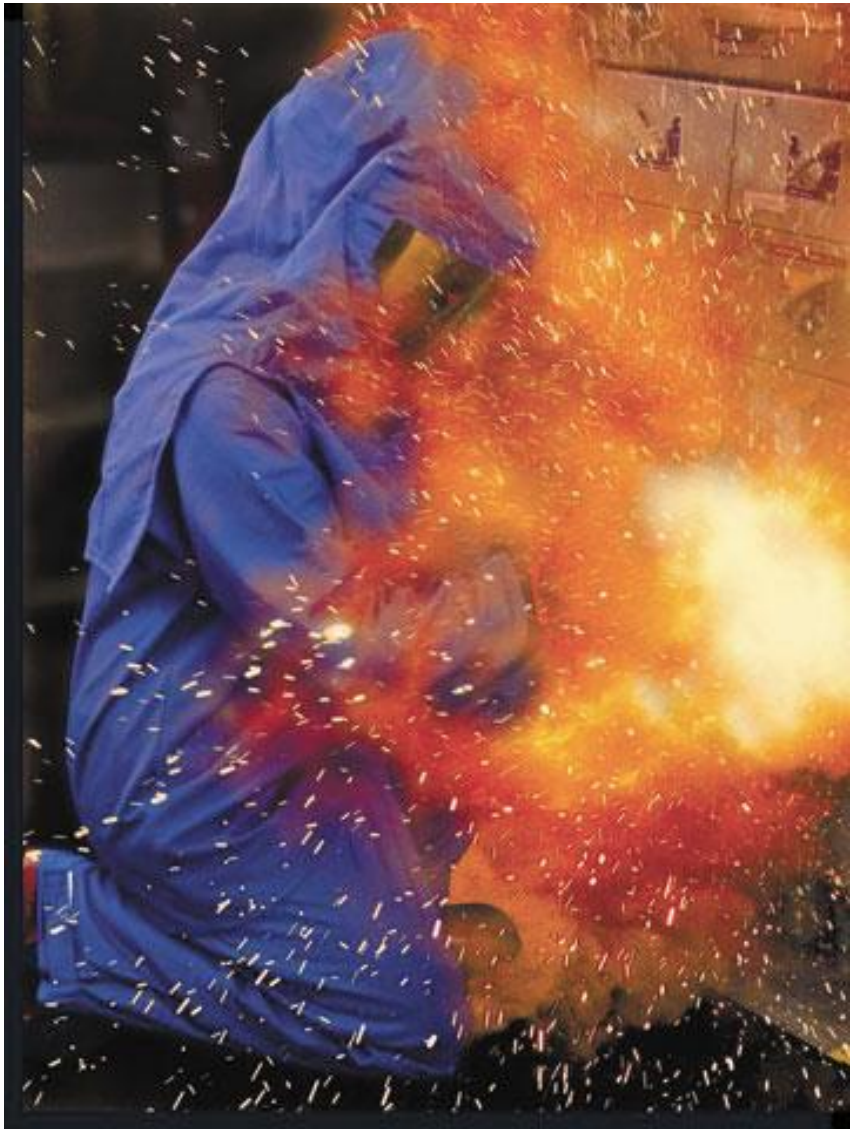

WARNING
Arc Flash and Shock Hazard
Appropriate PPE Required
4.9
cal/cm2 Flash Hazard at 18 Inches
#2
PPE Level
Cotton underwear plus FR shirt and FR pants
0.48
kV Shock Hazard when cover is removed
3' - 6"
Limited Approach
1' - 0"
Restricted Approach - Class 00 Voltage Gloves
0' - 1"
Prohibited Approach - Class 00 VoltageGloves
Equipment Name SWG-2A
IEEE 1584 Hazards; Project 1289A -- Safety Procedure #A6D24 --
EasyPower File: "Plant-A6.dez" -- Date: September 9, 2003


DANGER
Arc Flash and Shock Hazard
Nominal System Voltage
Arc Flash Boundary
Restricted Approach
Limited Approach
Incident Energy (cal/cm²)
Working Distance
OR
PPE Hazard Category
Arc Rating of Clothing
Arc-rated PPE:
Long-sleeve shirt
Flash suit jacket
Flash suit pants
Flash suit hood
Pants
Face shield
Balaclava
Gloves
Jacket
Parka
Rainwear
Coverall
Hard hat liner
Additional PPE:
Hard hat
Safety goggles
Safety glasses
Hearing protection
Heavy duty leather gloves
Leather footwear
Equipment ID:
BRADY #145974 BRADYID.COM Y4118038

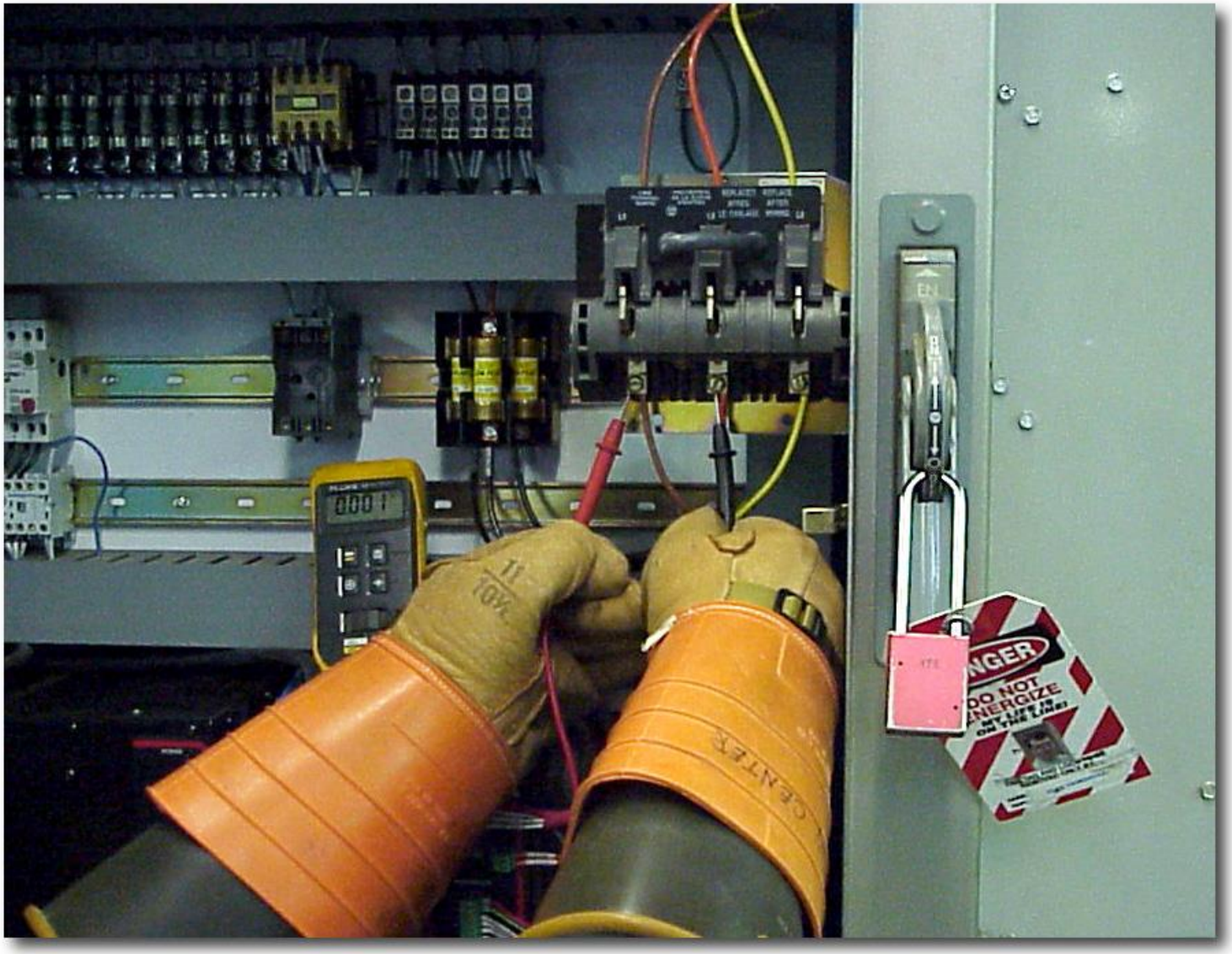
NFPA -70E Requirements

- Establish Electrically Safe Work Condition (ESWC)

- Specific Qualifications



Safe Work Conditions



Competent Person v/s Qualified Persons

- "Competent person" is defined as "one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them."

- **"Qualified"** person who has more technical expertise

"**Qualified**" employees entering and working within restricted areas must meet such training normally provided to a qualified electrical worker.

- Qualified employees must have the following minimum training:

  - ✓ They must know what is safe to touch and what is not safe to touch
  - ✓ They must know what the maximum voltage of the area
  - ✓ They must know the minimum approach distances for the maximum voltage within the area
  - ✓ They must be trained in the recognition and proper use of protective equipment

(*note: only qualified electrical employees may install insulating equipment on energized parts*)

Don’t let this happen to you….