

NFPA 70E
Standard on Electrical Safety in the
Workplace
An Overview

NSRP Meeting
May 23, 2006
Jacksonville, FL

Facility Electrical Safety

- Importance of Electrical Safety
- Hazard Identification
- OSHA Requirements
- Protective Strategies
- Safety Related Work Practices
- Safety Guidelines

Why be concerned about electrical safety?

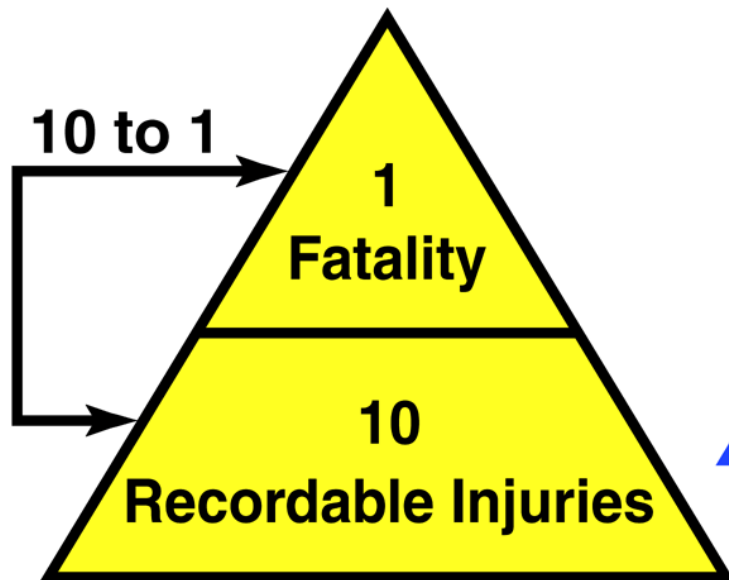
- Comply with applicable regulations
- Reduce injuries
- Reduce liability
- Reduce operating costs
- Provide a safe work environment

Electrical Safety Statistics

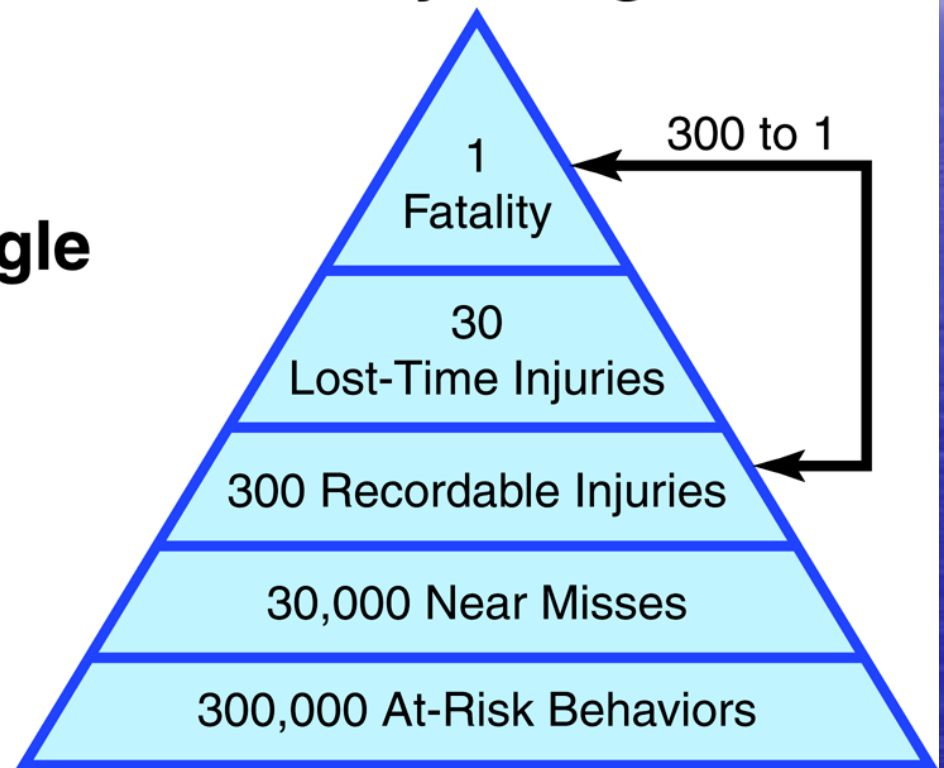
- Average of 4,000 non-disabling and 3,600 disabling electrical contact injuries annually in the United States
- One person is electrocuted in the workplace every day
- Electrocutions were the fourth leading cause of traumatic occupational fatalities.
- Over 2,000 workers are sent to burn centers each year with electrical-related burn injuries

Safety Triangle

Electrical Safety Triangle



Safety Triangle



Electrical Hazards

- Fire ignition
- Electric shock
- Arc flash
- Arc blast
- Other hazards

Fire Ignition

- The original and primary mission of NFPA
- Primarily covered by installation standards contained in NFPA 70, *National Electrical Code*
- However, not the target of NFPA 70E

Exposure to Shock

- A shock requires exposure to a difference of potential
- The *National Electrical Code* reduces this risk under normal conditions.
- NFPA 70E reduces the risk under abnormal conditions.



Electric Shock

- The original purpose of NFPA 70E
- To eliminate this hazard, we need to know:
 - The source of the hazard
 - How the exposure could occur
 - How the human body would react
 - What action is necessary

Mitigating Exposure to Electric Shock

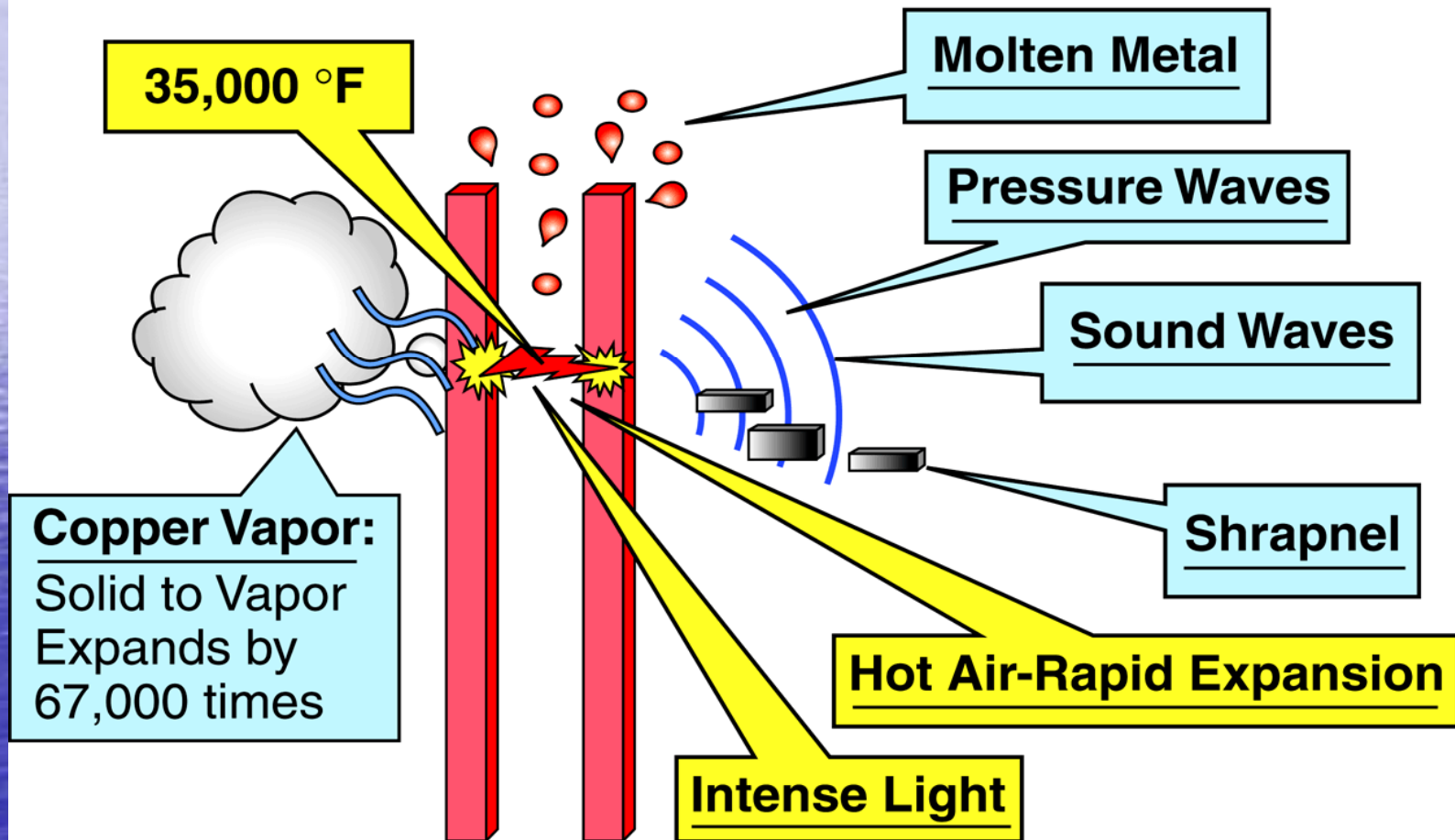
- Could the circuit be deenergized?
- If not, how could the exposure occur?
- How would the human body react?
- What action would minimize the hazard?
- What PPE would minimize the exposure?

Arc Flash

- What is it?
- How can I manage it?
- How can I reduce exposure?

Arc Flash and Arc Blast

Electrical Arc



Arc Flash in Real Time

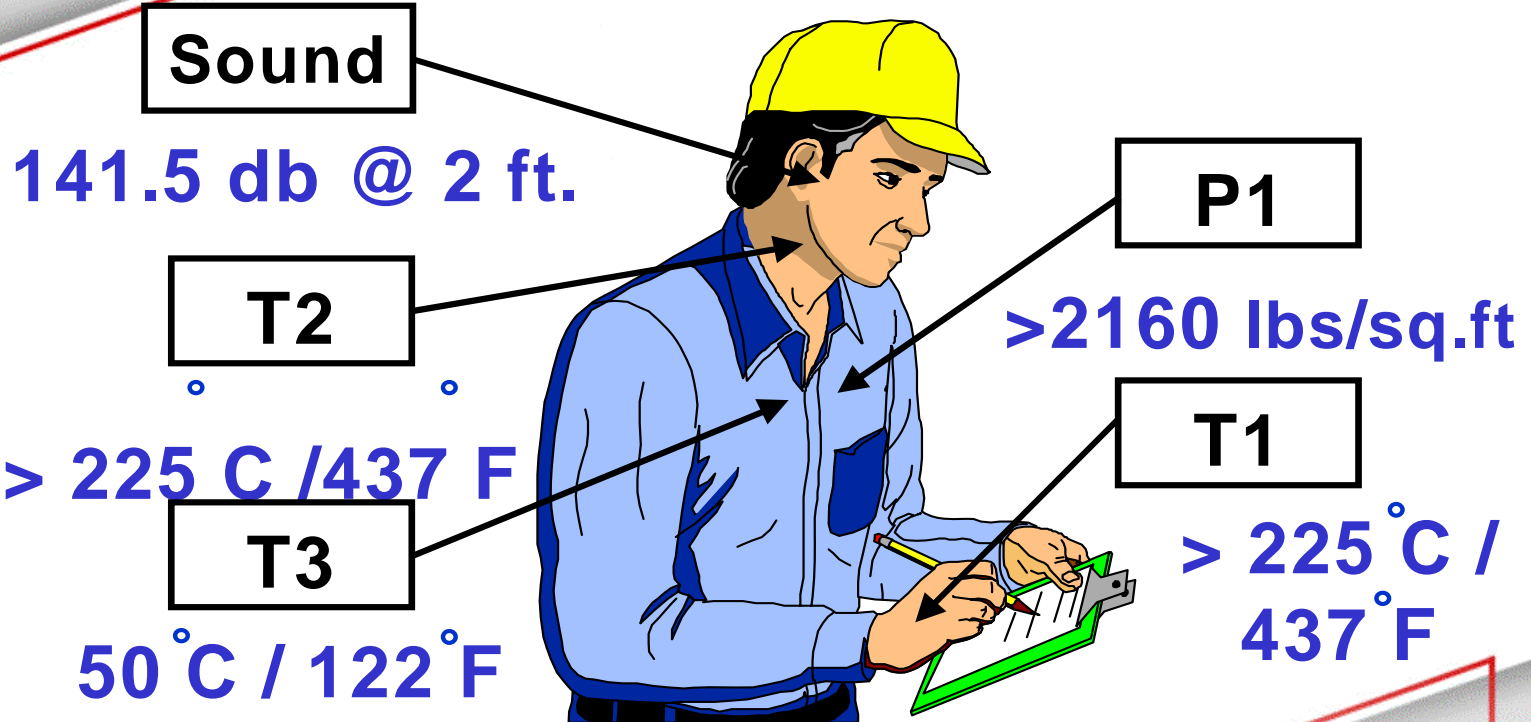


Arc Flash in Real Time



Arc Blast

Results: Test No.4



> Indicates Meter Pegged

Hazard/Risk Analysis

- Establish Shock Protection Boundary
- Conduct Flash Hazard Analysis
- Establish Flash Protection Boundary
- Select Personal Protective Equipment

Distance Boundaries

- Two types include the following:
 - Approach Boundaries are used to reduce shock hazard
 - Flash Protection Boundaries are used to reduce arc flash hazards and may reduce arc blast hazards

Limited Approach Boundary

- Outer-most boundary
- May be crossed only by qualified person
- May not be crossed by unqualified persons unless escorted by a qualified person

Restricted Approach Boundary

- Middle boundary
- Reserved for qualified persons
- Shock-protection techniques and safety equipment are required

Prohibited Approach Boundary

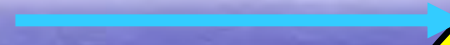
- Closest boundary
- Reserved for qualified persons
- Requires same protection as direct contact with a live part

Flash Protection Boundaries

- Methods to determine Flash Protection Boundaries using NFPA 70E
 - Default, or
 - Calculations

Approach Boundary to Live Parts

Limited (42 in)



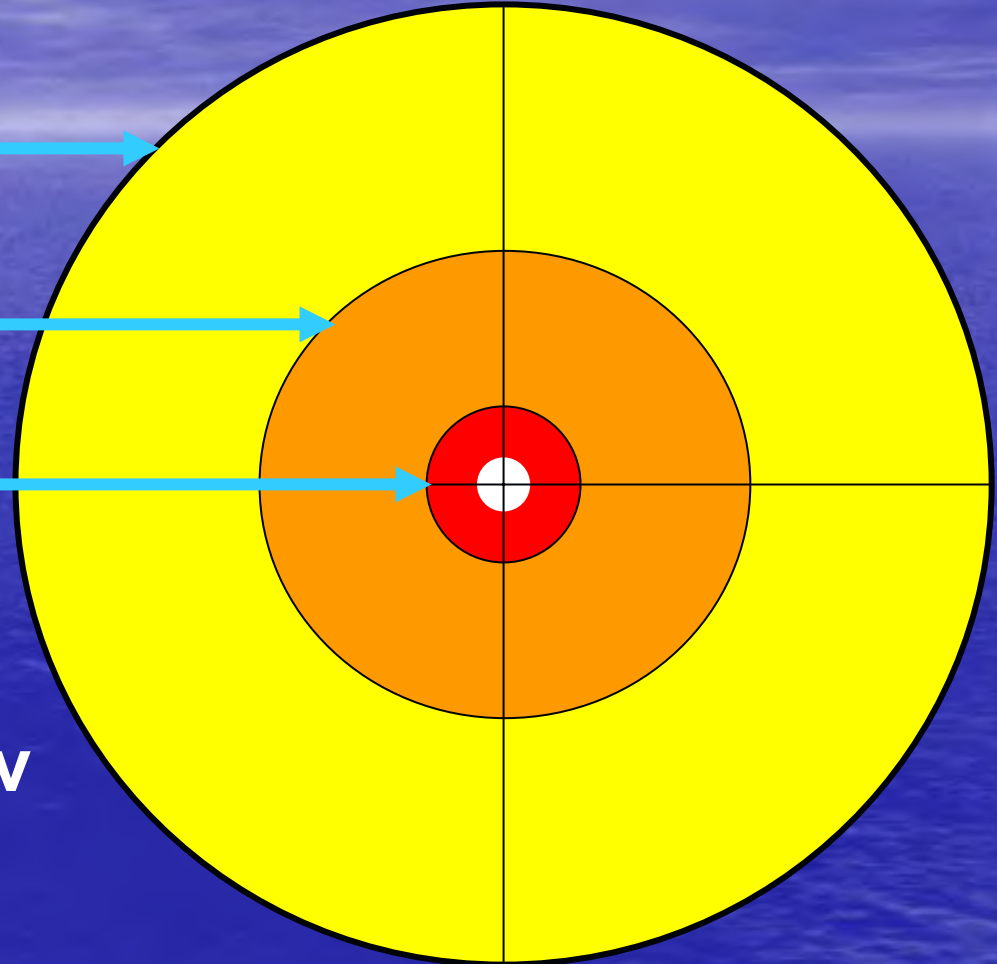
Restricted (12 in)



Prohibited (1 in)



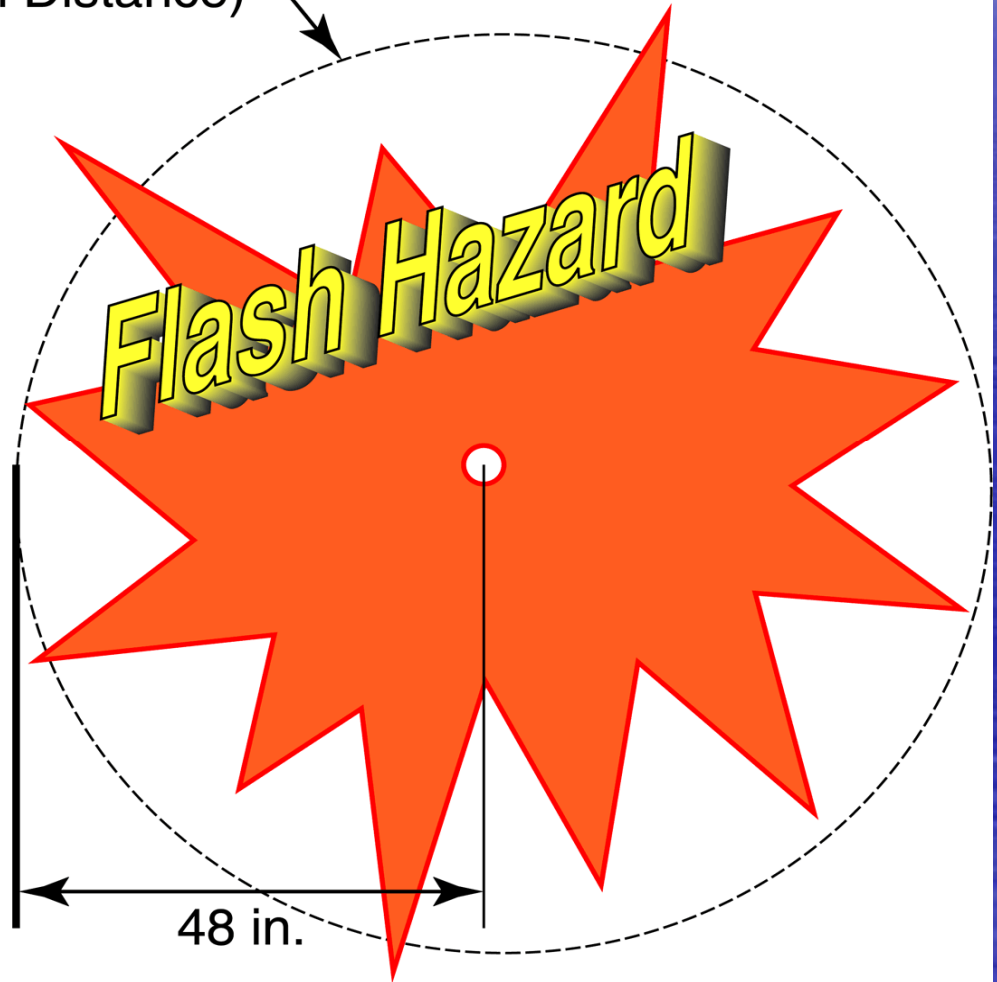
System Voltage = 480 v



Just how close is safe?

Flash Protection Boundary: Burns

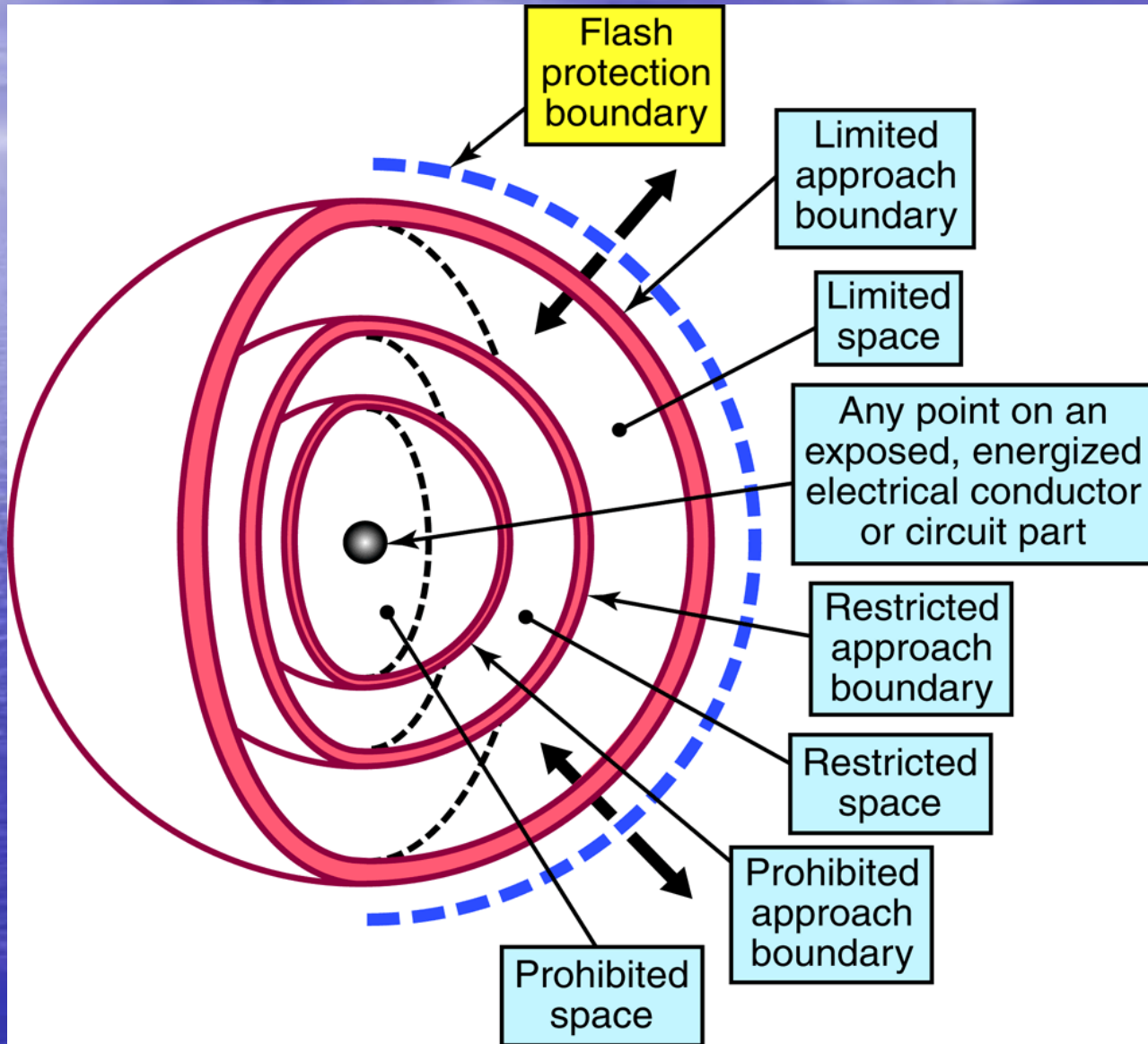
Flash Protection Boundary
(Curable Burn Distance)



Default Flash Boundary

- A 4-foot boundary may be used for basic systems:
 - 50 - 600 volts maximum
 - Up to 50kA available and 6-cycle clearing time
 - Or other combinations up to 300kA cycles
 - Calculations are permitted

Limits of Approach — Summary



OSHA Electrical Safety Regulations

The Code of Federal Regulations (CFR) 1910, Subpart S, contains the electrical safety regulations. This document

- Is the law, and is enforceable
- Is written in compliance-based language
- Does not generally provide remediation for safety

OSHA and NFPA 70E

- OSHA adopted the 1968 edition of the *National Electrical Code*[®] (*NEC*[®]) and, later, the 1971 edition
- However, the *NEC* was not sufficient for workplace safety
- NFPA developed NFPA 70E in cooperation with OSHA

OSHA General Industry Regulations

- General Industry
 - OSHA Act
 - 29 CFR 1910 Subpart S - Electrical
 - 29 CFR 1910 Subpart I - PPE
 - 29 CFR 1910 Subpart J - General Environmental Controls
 - 29 CFR 1910 Subpart R - Special Industries

OSHA General Industry Electrical Regulations

- 29 CFR 1910 Subpart S - Electrical
 - 1910.302-1910.308 Installation Requirements
 - 1910.331 Safety Related Work Practices
 - 1910.332 Training
 - 1910.333 Lockout/Tagout
 - 1910.335 Use of Protective Equipment

Structure of NFPA 70E

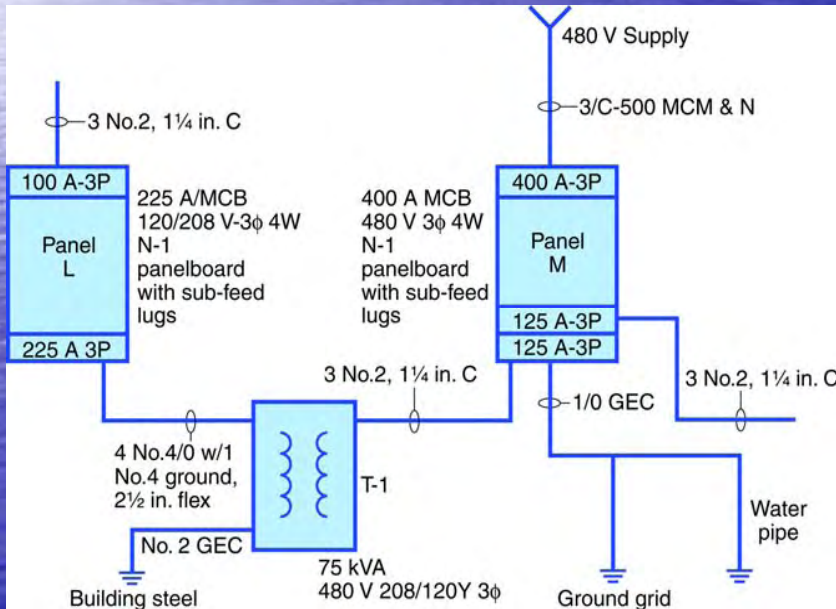
- NFPA 70E has a four-part structure similar to 29 CFR 1910, Subpart S:
 - Chapter 1 - Safety-Related Work Practices
 - Chapter 2 - Safety-Related Maintenance Requirements
 - Chapter 3 - Safety Requirements for Special Equipment
 - Chapter 4 - *NEC*[®] -Related Installation Material

Protective Strategies Embedded in NFPA 70E-2004

- Electrically safe work condition
- Training
- Planning
- PPE

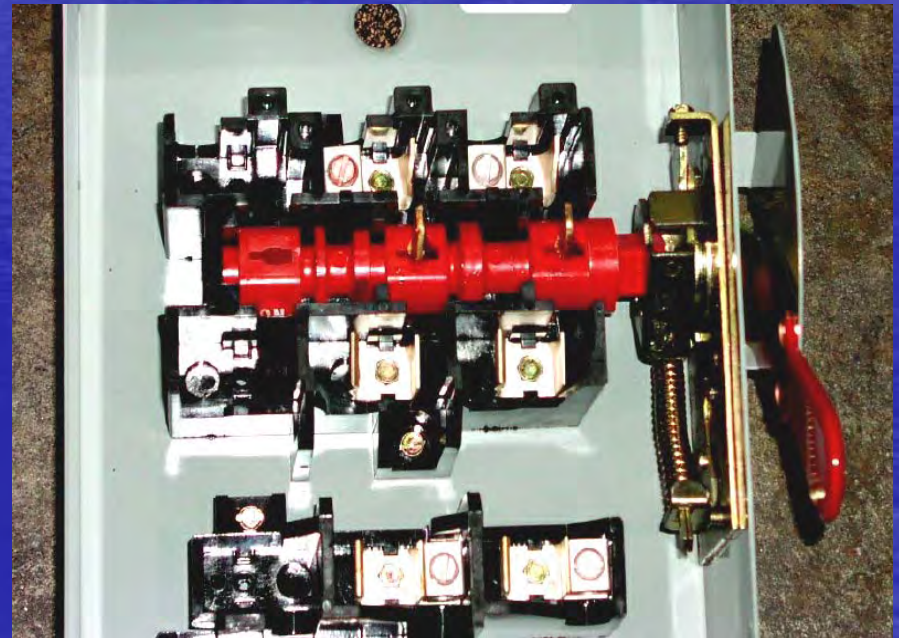
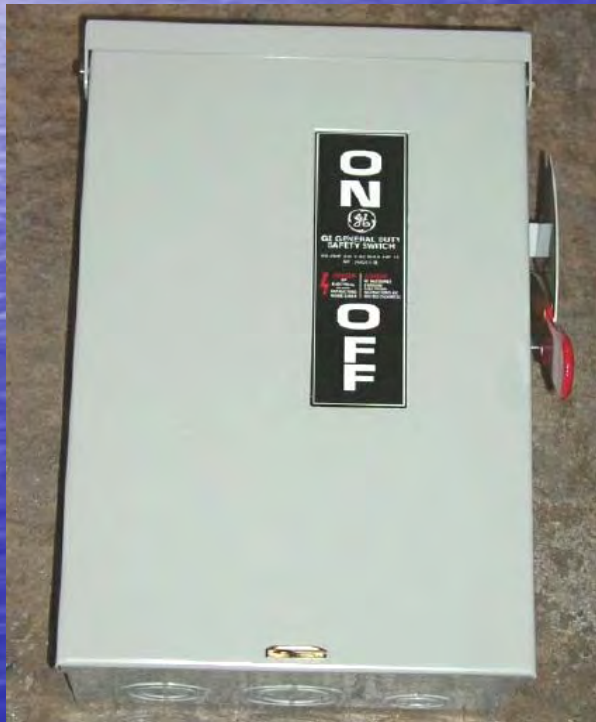
Creating an Electrically Safe Work Condition

- Check drawings and identify all possible sources
- Verify operation of tester



Creating an Electrically Safe Work Condition

- Interrupt load current, open disconnects
- Visually verify opening of contacts where possible



Creating an Electrically Safe Work Condition

- Apply lockout/tagout devices
- Test voltage devices



Creating an Electrically Safe Work Condition

- Verify operation of tester
- Apply grounds where necessary



Training Requirements

- Who is required to be trained?
 - Training must be provided to employees who face a risk of electrical hazard
 - Employees involved in LO/TO procedures must be trained
- What level of training is necessary?
 - The level of training must be adequate for the tasks involved
- What type of training can I use?
- How often or how much training do I need?

Qualified Person

- “One who has skills and knowledge related to the construction and operation of the electrical equipment and installations *and has received safety training on the hazards involved.*”

Planning:

Energized Electrical Work Permit

- Requires written authorization
- Requires the worker to do the following:
 - Identify and understand the hazards
 - Be a qualified person
 - Wear proper PPE
 - Restrict access to unqualified persons
 - Complete a job briefing

Planning: Job Briefing

- The job briefing includes the following:
 - Identify
 - Ask
 - Check
 - Know
 - Think
 - Prepare for an emergency

Identify

- The hazards
- The voltage levels involved
- Skills required
- Any “foreign” (secondary source) voltage source
- Any unusual work conditions
- Number of people needed to do the job
- The shock protection boundaries
- The available incident energy
- Potential for arc flash (Conduct a flash-hazard analysis.)
- Flash protection boundary

Ask

- Can the equipment be de-energized?
- Are backfeeds of the circuits to be worked on possible?
- Is a “standby person” required?

Check

- Job plans
- Single-line diagrams and vendor prints
- Status board
- Information on plant and vendor resources is up to date
- Safety procedures
- Vendor information
- Individuals are familiar with the facility

Know

- What the job is
- Who else needs to know—Communicate!
- Who is in charge

Think

- About the unexpected event . . . What if?
- Lock — Tag — Test — Try
- Test for voltage — FIRST
- Use the right tools and equipment, including PPE
- Install and remove grounds
- Install barriers and barricades
- What else . . . ?

Prepare for an emergency

- Is the standby person CPR trained?
- Is the required emergency equipment available? Where is it?
- Where is the nearest telephone?
- Where is the fire alarm?
- Is confined space rescue available?
- What is the exact work location?
- How is the equipment shut off in an emergency?
- Are the emergency telephone numbers known?
- Where is the fire extinguisher?
- Are radio communications available?

Personal Protective Equipment



PPE for Electrical Workers

- Protects against shock and burns
- Protects specific areas of the body
 - Head, face, neck, chin
 - Eye protection
 - Body protection
 - Hand and arm protection
 - Foot and leg protection

Flash Protection Boundaries and PPE

- When working within the flash protection boundary, PPE must be worn
- PPE is determined by the level of incident energy exposure

Performance Requirements of Protective Clothing

- Flame resistant
- Will not break or tear open
- Will not melt
- Will reduce heat transfer to the body

Basic Rules of PPE

- Layering
 - Outer layers
 - Under layers
- Coverage
- Fit
- Maintenance of equipment

Purchasing PPE

- Refer to the following tables:
 - Table 130.7 (C)(8) for PPE
 - Table 130.7 (F) for other protective equipment

Selecting PPE

- If clothing rating is equal to or greater than the degree of arc flash hazard, then the worker is protected from second degree burns
- Three step process:
 - Determine the hazard/risk category
 - Use the PPE Matrix
 - Choose appropriate clothing system

Levels of Exposure

Calculated Incident Energy	Hazard Risk Category	Minimum PTPV Rating
Up to 1.2 Cal/cm ²	Category 0	(N/A)
1.2 to 4 Cal/cm ²	Category 1	4
4.1 to 8 Cal/cm ²	Category 2	8
8.1 to 25 Cal/cm ²	Category 3	25
25.1 to 40 Cal/cm ²	Category 4	40
Over 40 Cal/cm ²	No category – Not permitted	

PPE for Category 1

- Long pants and long-sleeve shirt, FR for 4 calories
 - Regular weight denim pants permitted to be substituted
 - 4 calorie coverall may be substituted
- Hard hat, safety glasses
- Voltage-rated gloves with leather protectors

Summary

- First, identify and recognize the hazards
- Identify the affected parties
- Provide awareness training for unqualified people
- Provide protective schemes and training for qualified people
- ***Written documentation is the key***