NFPA 70E

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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
Electrical Hazards

- Electrical Shock
- Arc-Flash
- Arc-Blast
- Falls
- Fire
Electrical Shock = Current Flow through the Body

- Three major factors in electrical shock incidents:
  - The Path that current takes through the body
  - The amount of current that flows through the body
  - The amount of time that current flows through the body
Electrical Shock Review

- Sensation of pain .4ma
- Painful at levels above 2ma
- Muscle Contraction and Pain  3ma
- “Let Go” Threshold  above 9ma
- Respiratory Paralysis  30-75ma
- Heart Fibrillation  100-200ma
- Tissue and organs burn  1,500ma
Electrical Arc

**Copper Vapor:**
Solid to Vapor
Expands by 67,000 times

- 35,000 °F
- Intense Light
- Hot Air-Rapid Expansion
- Pressure Waves
- Sound Waves
- Molten Metal
- Shrapnel

Intense Light
Arc Flash Hazards

- Arc temperatures are extremely high
- At the point of contact, 35,000ºF, easily achievable
- In the workers ambient space, 15,000ºF, easily achievable
- The result is a conductive plasma fireball made of vaporized and molten metals
Arc Flash Hazards

Second degree burn threshold is:

- 80 °C / 175 °F (0.1 sec), 2\textsuperscript{nd} degree

Third degree burn threshold is:

- 96 °C / 205 °F (0.1 sec), 3\textsuperscript{rd} degree

The results of Arc Flash exposure are 2\textsuperscript{nd} degree burns (curable), 3\textsuperscript{rd} degree burns (incurable) & damage to the eyes
Arc Blast Hazards

- Extreme pressure from expansion of vaporizing metals and super heated air
- When water vaporizes it expands by a factor of 1,670
- When copper vaporizes it expands by a factor of 67,000
- An Arc Blast is comparable to a C4 explosion, or a hand grenade
15,000 Volt Electrical Incident
Job assignment

- Perform preventive maintenance for food processing plant emergency power system.
- Perform work on a holiday weekend.
- Record data on performance of system.
Scope of job

- Work to be performed on Memorial Day morning. Start work at 7:00 AM and finish at 11:00 AM.
- Open 15 KV switch to start emergency generator.
- Run generator for 3 hours under load to test reliability of system.
- Record ampere, water temperature, and oil pressure on generator.
Personnel

- Electrical supervisor, electrician, and technician.

- All workers had minimum of 5 years of experience.

- All workers had performed this type of work in the past.
Effect on workers

- Two workers had 2\textsuperscript{nd} and 3\textsuperscript{rd} degree burns on 60% of their bodies.
- One of the workers was placed in a drug induced coma for over 60 days.
- The third worker had initial minor injuries. He has suffered long term effects including neurological problems.
- Three families will never be the same again.
Post evaluation

- No hazard analysis.
- Workers could not cite the three hazards in the workplace.
- Workers were not properly trained.
- Workers were wearing polyblend clothing.
- All three workers were within the flash protection boundary.
End results

- Lost three long term employees
- OSHA citation and fine
- Negative publicity
- Litigation
480 Volt Electrical Incident
Company Information

- In business for 9 years
- 3 employees at the job site; 15 total in the Company
- OSHA History: No history with OSHA, had never been inspected.
- OSHA Recordkeeping: Only minor incidents, no lost time.
Work to be Conducted

- Removal of an existing 3 phase 480 volt circuit breaker and hardware (fingers, contacts) from a 1,000 amp 3 phase 480 volt Main Distribution Panel.
Incident Information

- PPE was limited to one pair of Class 1 electrical gloves and one pair of leather insulated glove protectors for both workers.
Incident Information

- The Foreman dropped his screwdriver and proceeded to get another one.

- The Owner’s pliers began to lose their grip on the “finger” and he expressed the need to hurry up to the foremen.
CRITICAL CHOICE
Something Went Wrong
Effects of the Incident

- Both men were seriously burned and were transported by Helicopter and Ambulance to the Burn Center.
Effects of the Incident

- Owner had 1st 2nd and 3rd degree burns and was hospitalized for 6 weeks with several months of physical and psychological therapy.

- Journeyman also suffered 1st 2nd & 3rd degree burns but very limited.
Electrical Safety in the Workplace

OSHA Requirements
29 CFR 1910.333(a)(1)

Live parts to which an employee may be exposed **shall** be deenergized before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.
NOTES

- Interruption of life support equipment
- Deactivation of emergency alarm systems
- Shutdown of hazardous location ventilation equipment
NOTES Continued

- Testing of electrical circuits that can only be performed energized

- Integral part of a continuous industrial process (chemical plant)

- ALL OTHER WORK DEENERGIZED
OSHA Methods of Enforcement

- The General Duty Clause - Requires workplaces free from recognized hazards
- Recognized hazard in the industry
- NFPA 70E is an industry standard
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
Electrical Safety in the Workplace

~ Working On or Near Live Parts
One who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved.
NFPA 70E Requirements for Working on or Near Live Parts

- Complete Energized Electrical Work Permit
- Perform Hazard/Risk Analysis
- Select Personal Protective Equipment
- Ensure task-specific training
- Conduct a job briefing
Energized Electrical Work Permit

- Requires written authorization
- Requires the worker to:
  - Identify and understand the hazards
  - Be a qualified person
  - Use proper PPE
  - Restrict access to unqualified persons
  - Complete a job briefing
Hazard/Risk Analysis

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

Two types include:

- Approach Boundaries - used to reduce shock hazard
- Flash Protection Boundaries - used to reduce arc flash hazards and may reduce arc blast hazards
Approach Boundary to Live Parts

Limited (42 in)

Restricted (12 in)

Prohibited (1 in)

System Voltage = 480 v
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 Boundary: Burns

Flash Protection Boundary
(Curable Burn Distance)
Flash Protection Boundaries

- Methods to determine Flash Protection Boundaries using NFPA 70E
  - Default or Tables
  - Calculations
Section 110.7(G) requires a job briefing before:

- Starting each job
- Any change in scope of a job
Personal Protective Equipment
What is PPE?

- Protective scheme for electrical hazards
- Designed to protect specific areas of the body
  - Head, face, neck, chin
  - Eye protection
  - Body protection
  - Hand and arm protection
  - Foot and leg protection
## Levels of Exposure

<table>
<thead>
<tr>
<th>Calculated Incident Energy</th>
<th>Hazard Risk Category</th>
<th>Minimum ATPV Rating</th>
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<tbody>
<tr>
<td>Up to 1.2 Cal/Cm²</td>
<td>Category 0</td>
<td>(N/A)</td>
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<td>1.2 to 4 Cal/Cm²</td>
<td>Category 1</td>
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<td>4.1 to 8 Cal/Cm²</td>
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<td>40</td>
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<tr>
<td>Over 40 Cal/Cm²</td>
<td>No Category – Not Permitted</td>
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Basic Rules of PPE

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

- Melting
- Flammability
- Not permitted
Program Analysis

- Electrical Safety is a four step analysis process
  - Establish electrically safe work
  - Provide training
  - Plan the work
  - Use Personal Protective Equipment where applicable
NFPA 70

2002 NEC Arc Flash Hazard Marking Requirement

Section 110.16 Flash Protection
240 volt Live Panel Board
Program Summary

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

Comments

Concerns