What’s up with Arc Flash?

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What is Arc Flash?

Definition

- An arc flash or arc explosion is the passage of a substantial electric current through ionized air.
- It is characterized as being:
  - Less than one second in duration
  - Extremely high in radiant energy
  - Explosive in nature
When Does it Happen?

- Arc Flash happens while making or breaking contact within an electrical system.
- Examples include:
  - Low voltage – operating a light switch, opening & closing breakers, making contact during energized work.
  - Medium voltage – racking (removing and replacing) breakers or fuses.
  - Opening closing switchgear, busses, etc.
  - As a result of a system fault.
How Can it Affect Me?

● Arc Flash is the “other half of the electrical safety equation”
  - Shock hazards are about current, voltage and resistance (...Ohm’s Law)
  - Arc flash hazards are about the heat energy resulting from current flow through air across contacts

● Arc flash can lead to severe burns and nerve damage, especially with voltages of 480 V and higher.
### Important Temperatures

<table>
<thead>
<tr>
<th>Description</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin temperature for curable burn</td>
<td>176°F</td>
</tr>
<tr>
<td>Skin temperature causing cell death</td>
<td>205°F</td>
</tr>
<tr>
<td>Ignition of clothing</td>
<td>752°-1472°F</td>
</tr>
<tr>
<td>Burning clothing</td>
<td>1472°F</td>
</tr>
<tr>
<td>Metal droplets from arcing</td>
<td>1832°F</td>
</tr>
<tr>
<td>Surface of sun</td>
<td>9000°F</td>
</tr>
<tr>
<td>Arc terminals</td>
<td>35,000°F</td>
</tr>
</tbody>
</table>
How Do We Protect Employees?

- Practice electrical safety 101
- Don’t work on exposed energized circuits!
- Use **lockout tagout** procedures to isolate hazardous energy
- Make sure employees are qualified, authorized and properly trained
- Use proper tools and PPE
- Implement a comprehensive electrical safety program
What if We Need to Work Energized?

- Try to keep the arc in the box
  - An arc flash that is at least partially contained in the electrical cabinet is less likely to cause serious harm

- Distance is your friend!
  - Know and abide by “safe working distances”
    - Arc Flash Boundary: incident energy > 1.2 cal/cm²
    - Limited approach boundary: shock
    - Restricted approach boundary: shock
    - Prohibited approach boundary: shock
  - Distances vary due to many variables

- Use appropriate voltage and arc rated PPE
NFPA 70E® 2012
Arc Flash Boundary

Calculated for Each Task

<table>
<thead>
<tr>
<th>Boundary</th>
<th>Injury</th>
<th>PPE Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside</td>
<td>2\textsuperscript{nd} Degree Burn</td>
<td>Not Expected</td>
</tr>
<tr>
<td>Arc Rated Clothing &amp; PPE</td>
<td>Not Required</td>
<td></td>
</tr>
<tr>
<td>Inside</td>
<td>2\textsuperscript{nd} + Degree Burn</td>
<td>Is Predicted</td>
</tr>
<tr>
<td>Arc Rated Clothing &amp; PPE</td>
<td>Required</td>
<td></td>
</tr>
</tbody>
</table>
Electric Arc Blast - Untreated Cotton Shirt

Before Electric Arc Blast  |  During Electric Arc Blast  |  After Electric Arc Blast
Establish an Electrical Safety Program

- Standards to follow
  - OSHA 1910.147, and Subpart S
  - NFPA 70E® 2012

- Electrical Safety Program Principles
  - Inspect, evaluate and maintain the electrical equipment
  - Plan each job and expect the unexpected
  - De-energize if possible
  - Identify and minimize hazards
  - Protect people from shocks, burns and blasts
  - Use the right tools
  - Use the right people
  - Audit the program
Protecting from Arc Flash

- Perform an assessment
  - Identify electrical hazards
  - Start at the source (utility/main power feed)
  - Step through to the control panel level
- Identify tasks performed and frequency
- Gather the data to **calculate**
  the incident energy fault potential
Case Study

- Small Power Plant at 15 megawatts
- Arc Fault blast at 4160 VAC metering a racked out breaker with a lack of a formal program, incorrect meter and inadequate PPE
- Employee injuries: severe burns to face chest and arms with nerve damage
- What was the fix?
4160 Volt Switchgear Breaker
Case Study

- Assessment of loads, tasks, contact points, procedures, PPE and training
- Calculation of the incident energy with output in cal/cm²
- Redesign of some equipment
- Development of new procedures
- Labeling
- Spec and procure new PPE
- Training and implementation
What Does OSHA Cite For?

- Citations largely under 29CFR 1910 Subpart S
  - 1910.132(d)(1) PPE Assessment
  - 1910.332(b) Content of Training. Trained in and familiar with safety related work practices pertaining to their respective assignments
  - 1910.335(a)(1)(i) Use of Protective Equipment. Use electrical PPE for specific body parts
  - 1910.335(a)(1)(iv) Protective Equipment. Non-conductive head protection
  - 1910.335(a)(1)(v) Protective Equipment. Use PPE for eyes and face when there is danger from electrical arcs, flashes or explosions
  - 1910.335(a)(2) Protective Equipment. Use of insulated tools
  - 1910.269(l)(6)(ii) & (iii) Apparel. Train on hazards of flames or electric arcs. Ensure employees exposed to hazards of flames or electric arcs do not wear clothing that can increase extent of injury
Summary

- Arc Flash is a significant electrical hazard for both qualified and unqualified workers.
- Hazards include high heat, pressure and noise.
- A comprehensive electrical safety program is needed to protect workers.
- PPE can be an effective protective method.
- Current OSHA Standards are often cited for arc flash hazards.
- NFPA 70E is often the remedy for those citations.
Thank you!

Questions and Answers