NFPA 70E 2015
Electrical Safety in the Workplace
Arc Flash & Energized Electrical Work Hazards
Donnie’s Accident

Caution: Several of the following images are very graphic.
OSHA’S Role in Enforcement

OSHA CFR 29 1910.333(a)(1):

“Live parts to which an employee may be exposed shall be de-energized before the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Live parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.”
Examples of increased or additional hazards include interruption of life support equipment, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment.
CFR 29 1910.333 (a)(1) NOTE 2:

“Examples of infeasibility due to equipment design or operational limitations include testing of electric circuits that can only be performed with the circuit energized. . . .”

Includes: Startup, Troubleshooting, Diagnostics and Testing.
The Facts of Arc Flash

- Each year more than 2000 people are admitted to burn centers with severe Arc Flash burns.
- 10 Arc Flash incidents per day resulting in 1 – 2 deaths per day.
- Arc Flash injuries occur 1,000 times more often than a shark attack.
The Facts of Shock

- Approximately 30,000 nonfatal electrical shock accidents occur each year.

- The National Safety Council estimates that about 1000 fatalities each year are due to electrocution, more than half of them while servicing energized systems of less than 600 volts.
What is Arc Flash?

Arc Flash occurs when an electric arc passes through air between:
- Ungrounded conductors
- Ungrounded conductors and grounded conductors

Temperatures can reach 35,000 Degree Fahrenheit
What is an Arc Flash?

Electrical Arc

- 35,000 Degree F
- Molten Metal
- Pressure Shock Waves
- Defeating Sound Wave
- Shrapnel
- Hot Toxic Air – Rapid Expansion
- Blinding Light

Copper Vapor
Solid to Vapor
Expands
67,000 times
Electric arcs: The “energized electrical work” we do!

- Remove electrical equipment panels and doors
- Voltage & current measurements, infrared thermography
- Troubleshooting
- Installing new breakers, disconnect switches, conduit/circuits
- Construction – drilling, knock outs
Arc Flash
The amount of energy (4 types) released is dependent upon another 2 Main factors:

1. **Fault Current** – amount of current that the electrical system can deliver, at a particular place on the electric system. Dependent upon short circuit and coordination.

2. **Time** – the length, in seconds, that is required for protective device to open or disconnect.
The best way to determine the potential hazard of an arc flash is to conduct an Arc Flash Hazard Assessment (AFHA) before work begins.

FPN #1: NFPA 70E Provides assistance in determining the severity of potential exposure, planning safe work practices and selecting PPE
Module 2
Flash Protection Boundary and Limits of Approach
Protective Boundaries for Personnel

Arc Flash Protection Boundary
NFPA 70E-2015 Article 100©NFPA defines Arc Flash Protection Boundary as: When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur. (For a person not wearing arc flash/shock PPE)
The flash protection boundary is the closest approach allowed by qualified or unqualified persons without the use of Arc Flash PPE.
Limited Approach Boundary
NFPA 70E-2015 Article 100:

An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

An unqualified person cannot cross the boundary unless escorted by a qualified person.
Protective Boundaries for Personnel

Restricted Approach Boundary

NFPA 70E-2015 Article 100:

An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.
Protective Boundaries for Personnel

Adequate PPE for flash protection may be required during load interruption, **visual inspection** that verifies that all disconnecting devices are open, and during the lockout/tagout procedure.

Adequate PPE for flash protection is always required during **tests** that verify the absence of voltage after the circuits are de-energized.

Adequate PPE for flash protection is also required for **applying** or **removing grounds**.
Module 3
Qualified Personnel
Qualified Personnel To Perform Energized Electrical Work

Qualified Person (OSHA 29CFR1910)

Qualified persons are those who have training in avoiding the electrical hazards of working on or near exposed energized parts.

A qualified employee must be trained and competent to (1910.269a2ii)(1910.332b3):

- Distinguish live parts from other parts of equipment
- Determine the nominal voltage of live parts
- Know the minimum approach distances to live parts
Qualified Personnel To Perform Energized Electrical Work

Qualified Person (OSHA 29CFR1910) (Cont.)

Know what precautions to take to work safely, including:

• how to carry out lockout/tagout procedures
• how to manage and maintain a safe work area
• how to use protective grounds

Know how to use PPE

Know how to use insulating and shielding materials

Know how to use insulated tools
Qualified Personnel To Perform Energized Electrical Work

Work intentionally performed on or near energized equipment or circuits is limited by standards and regulations, such as those issued by OSHA.

- Only qualified persons may work on energized electric circuits (1910.333c2)
- Only qualified persons may perform tests on electric circuits or equipment (1910.334c1)
- Only qualified persons may work on or with exposed lines or parts of equipment (1910.269/1)
Module 4
Personal Protective Equipment
Protective Clothing And PPE For Arc Flash
Protective Clothing / PPE for Arc Flash

NFPA 70E 2012 Article 100:

Arc Rating: The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm² and is derived from the determined value of the arc thermal performance value (ATPV).
Protective Clothing / PPE for Arc Flash

*Watch out for synthetic blends!!*

- Synthetic fibers are easily ignited
- They are difficult to extinguish
- Damage the skin
- Difficult to treat burns from these fibers
- Increase the probability of infection
- Clothing containing acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric under layers (underwear) next to the skin
Protective Clothing / PPE for Arc Flash

OSHA requires that the clothing, which an employee wears, does not contribute to the severity of any injuries he or she incurs as a result of an electric arc.

- Includes the use of the prohibited fabrics in any layer of a multi-layer outfit (inside, middle, or outer).
- Best to use some type of flame-resistant (FR) clothing.
- Examples include FR cotton, Nomex and PBI/Kevlar.
Protective Clothing / PPE for Arc Flash

Choosing FR Clothing and PPE from an Electrical Flash Hazard Assessment

- NFPA 70E requires an employee to wear clothing with an arc rating at least as great as the predicted incident energy or the minimum PPE rating required for the Hazard Risk Category.
# Protective Clothing / PPE for Arc Flash

## PPE Category Level Chart NFPA 2009

<table>
<thead>
<tr>
<th>Category</th>
<th>What Personal Protection Equipment (PPE) You Shall Wear:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0</strong></td>
<td>[X] Cotton Undergarments</td>
</tr>
<tr>
<td></td>
<td>[X] Long Sleeved Shirt (Natural Fiber)</td>
</tr>
<tr>
<td></td>
<td>[X] Long Pants (Natural Fiber)</td>
</tr>
<tr>
<td></td>
<td>[X] Safety Glasses or Goggles</td>
</tr>
<tr>
<td></td>
<td>[X] Hearing Protection (Inserts)</td>
</tr>
<tr>
<td></td>
<td>[X] Leather Gloves (as needed) or Insulating Gloves w/Protectors</td>
</tr>
</tbody>
</table>

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<tr>
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</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>[X] Cotton Undergarments</td>
</tr>
<tr>
<td></td>
<td>[X] Arc Rated Long Sleeved Shirt (or FR Coveralls)</td>
</tr>
<tr>
<td></td>
<td>[X] Arc Rated Long Pants (or FR Coveralls)</td>
</tr>
<tr>
<td></td>
<td>[X] Hard Hat with Arc Rated Face Shield</td>
</tr>
<tr>
<td></td>
<td>[X] Hearing Protection (Inserts)</td>
</tr>
<tr>
<td></td>
<td>[X] Safety Glasses or Goggles</td>
</tr>
<tr>
<td></td>
<td>[X] Leather Gloves or Insulating Gloves w/Protectors</td>
</tr>
<tr>
<td></td>
<td>[X] Leather Shoes (as needed)</td>
</tr>
</tbody>
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<tbody>
<tr>
<td><strong>2</strong></td>
<td>[X] Cotton Undergarments</td>
</tr>
<tr>
<td></td>
<td>[X] Short Sleeved “T” Shirt (Natural Fiber)</td>
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<tr>
<td></td>
<td>[X] Arc Rated Long Sleeved Shirt and Long Pants</td>
</tr>
<tr>
<td></td>
<td>or Arc Rated Coveralls instead</td>
</tr>
<tr>
<td></td>
<td>[X] Hard Hat with Arc Rated Face Shield w/Sock Balaclava</td>
</tr>
<tr>
<td></td>
<td>[X] Safety Glasses or Goggles</td>
</tr>
<tr>
<td></td>
<td>[X] Hearing Protection (Inserts)</td>
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Protective Clothing / PPE for Arc Flash

Always wear voltage rated rubber glove liners when working above 50 volts in all categories!
Protective Clothing / PPE for Arc Flash

Eye and Face Protection

NFPA 70E 2012 130.7(C) (10) (c) Face Protection

Face shields shall have an arc rating suitable for the arc flash exposure. Face shields without an arc rating shall not be used. Eye Protection (safety glasses or goggles) shall always be worn under face shields or hoods.
Protective Clothing / PPE for Arc Flash

NFPA 70E 2012 130.7(C)

Maintenance and Use:
Electrical protective equipment shall be maintained in a safe, reliable condition. Insulating equipment shall be inspected for damage before each day’s use and immediately following any incident that can reasonably be suspected of having caused damage. Insulating gloves shall be given an air test, along with the inspection. Electrical protective equipment shall be subjected to periodic electrical tests.
Protective Clothing / PPE for Arc Flash

Footwear

NFPA 70E-2012 130.7(10)(e):
Arc Flash Protective Equipment

Foot Protection: Heavy-duty leather work shoes provide some arc flash protection to the feet and shall be used in all exposures greater than 4 cal/cm².
Thank You!

Work Safely Out There!

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