SAFETY MEETINGS

Arc Flash Awareness
Electrical Arc Flash

• Phenomenon where a flashover of electric current leaves its intended path and travels through the air from
  – One conductor to another
  – To the ground

• Caused by things such as
  – Dust
  – Dropping tools
  – Accidental touching
  – Condensation
  – Material failure
  – Corrosion
  – Faulty installation

The higher the voltage and the shorter the distance to the main power supply, the greater the arc and blast.
Electrical Arc Flash

Three factors determine severity of arc flash injury

1. Proximity of the worker to the hazard
2. Temperature
3. Time for circuit to break
Electrical Arc Flash Hazards

- Burns
- Fire
- Flying objects
  - Molten metal
- Blast pressure
  - Upwards of 2,000 pounds per square foot
- Sound blast
  - Noise can reach 140 decibels
- Heat
  - Upwards of 35,000°F
Approach Boundaries

The National Fire Protection Association (NFPA) developed specific approach boundaries designed to protect employees while working on or near energized equipment based on the worker’s distance away from the live part.
Approach Boundaries

- **Flash Protection Boundary**
  - Exposed to a curable 2° burn
  - PPE required to prevent incurable burns

- **Limited Approach**
  - Shock hazard exists
  - Closest an unqualified person can approach

- **Restricted Approach**
  - Increased risk of shock
  - Closest a qualified person can go without proper PPE and insulated tools

- **Prohibited Approach**
  - Considered to be the same as making contact with the live part
Approach Boundaries

- Limited Approach Boundary
- Flash Protection Boundary
- Restricted Approach Boundary
- Energized Equipment
<table>
<thead>
<tr>
<th>(1) Nominal System Voltage Range, Phase to Phase</th>
<th>(2) Limited Approach Boundary</th>
<th>(3) Restricted Approach Boundary</th>
<th>(4) Prohibited Approach Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposed moveable conductor</td>
<td>Exposed fixed circuit part</td>
<td>(Includes inadvertent movement adder)</td>
<td></td>
</tr>
<tr>
<td>Less than 50 V</td>
<td>Not specified</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>50 V – 300 V</td>
<td>10 ft. 0 in.</td>
<td>3 ft. 6 in.</td>
<td>Avoid contact</td>
</tr>
<tr>
<td>301 V – 750 V</td>
<td>10 ft. 0 in.</td>
<td>3 ft. 6 in.</td>
<td>1 ft. 0 in.</td>
</tr>
<tr>
<td>751 V – 15 kV</td>
<td>10 ft. 0 in.</td>
<td>5 ft. 0 in.</td>
<td>2 ft. 2 in.</td>
</tr>
<tr>
<td>15.1 kV – 36 kV</td>
<td>10 ft. 0 in.</td>
<td>6 ft. 0 in.</td>
<td>2 ft. 7 in.</td>
</tr>
<tr>
<td>36.1 kV – 46 kV</td>
<td>10 ft. 0 in.</td>
<td>8 ft. 0 in.</td>
<td>2 ft. 9 in.</td>
</tr>
<tr>
<td>46.1 kV – 72.5 kV</td>
<td>10 ft. 0 in.</td>
<td>8 ft. 0 in.</td>
<td>3 ft. 3 in.</td>
</tr>
</tbody>
</table>
### Protective Measures

**Power line Approach Distances for Qualified Workers**

<table>
<thead>
<tr>
<th>Voltage Range (AC) Minimum Approach</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 V and less</td>
<td>Avoid contact</td>
</tr>
<tr>
<td>300 V – 750 V</td>
<td>1 ft. 0 in.</td>
</tr>
<tr>
<td>750 V – 2 kV</td>
<td>1 ft. 6 in.</td>
</tr>
<tr>
<td>2 kV – 15 kV</td>
<td>2 ft. 0 in.</td>
</tr>
<tr>
<td>15 kV – 37 kV</td>
<td>3 ft. 0 in.</td>
</tr>
<tr>
<td>37 kV – 87.5 kV</td>
<td>3 ft. 6 in.</td>
</tr>
<tr>
<td>87.5 kV – 121 kV</td>
<td>4 ft. 0 in.</td>
</tr>
<tr>
<td>121 kV – 140 kV</td>
<td>4 ft. 6 in.</td>
</tr>
</tbody>
</table>
Protective Measures

Power lines

• Always assume energized unless proven otherwise
• Keep equipment at least 20 feet away
• Follow lockout/tagout procedures
• Determine location before performing work
Protective Measures

Use proper warning labels

• Equipment operating at 50 volts or more and not put into a de-energized state must be evaluated for arc flash and shock protection

• Evaluation determines
  – Actual boundaries
  – PPE

• After evaluation, Arc Flash Hazard warning label must be affixed to equipment and readily accessible
WARNING

Arc Flash Hazard
Appropriate PPE Required
Failure to Comply Can Result in
Death or Injury
Refer to NFPA 70E

Minimum Arc Flash Label Example

WARNING

Arc Flash Hazard
Appropriate PPE Required
Flash Hazard Boundary
Cal/cm² Flash Hazard at 18 inches
PPE Level
Cotton underwear plus FR shirt and FR pants

480 VAC shock hazard when cover is removed

42 inch Limited Approach – NO Unqualified Persons
12 inch Restricted Approach – 1000V Class 0 Gloves
1 inch Prohibited Approach – 1000V Class 0 Gloves

Equipment Name: Slurry Pump – 2A

Detailed Arc Flash Label Example
Protective Measures

- De-energize the circuit before starting work
  - Identify all power sources
  - Interrupt load and disconnect power
  - Visually verify that a disconnect has opened the circuit
  - Lock out/tag out the circuit
  - Test for voltage
  - Ground all power conductors
- Use guarding procedures
- Set up barricades
- Utilize ground fault circuit interrupters (GFCI)
- Use grounding as secondary protection

The most effective and fool-proof way to eliminate the risk of electrical shock or arc flash is to de-energize the equipment.
Protective Measures

If you are required to work “hot,” your employer must develop and enforce safety-related work practices which include

• Energized electrical work permits
• Personal protective equipment
• Insulated tools
• Written safety programs
• Job briefings
Protective Measures

PPE for shock and arc flash protection includes

• Safety glasses
• Voltage-rated gloves
• Fire-resistant or flame retardant work clothes
• Arc-rated face shields
• Flash suits with hoods
• Hearing protection
Protective Measures

Flame retardant clothing (FRC) meeting OSHA standards must be labeled with

• Tracking code
• Statement that the garment meets the requirements
• Manufacturer’s name
• Size information
• Care instructions
• Fiber content
• Arc rating
<table>
<thead>
<tr>
<th>Hazard/Risk Category</th>
<th>Clothing Description</th>
<th>Required Minimum Arc Rating of PPE [J/cm²(cal/cm²)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight of at least 4.5 oz/yd²</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>FR shirt and FR pants or FR coverall</td>
<td>16.74 (4)</td>
</tr>
<tr>
<td>2</td>
<td>Cotton underwear (conventional short sleeve shirt and briefs/shorts) <strong>plus</strong> FR shirt and FR pants</td>
<td>33/47 (8)</td>
</tr>
<tr>
<td>3</td>
<td>Cotton underwear <strong>plus</strong> FR shirt and FR pants <strong>plus</strong> FR coverall, or cotton underwear plus two FR coveralls</td>
<td>104.6 (25)</td>
</tr>
<tr>
<td>4</td>
<td>Cotton underwear <strong>plus</strong> FR shirt and FR pants <strong>plus</strong> multilayer flash suit</td>
<td>167.36 (40)</td>
</tr>
</tbody>
</table>
Protective Measures

Inspect wiring and cords before use

- Extension cords must have 3 prong grounding conductor
- Multiple plug adaptors are prohibited
- Exposed wiring and damaged cords must be repaired or replaced immediately
- Make sure flexible cords and cables are free of splices or taps
- Securing means provided on flexible cords, cables, and cord jackets must be held in place
Protective Measures

• Electrical installations in areas containing hazardous dust or vapor
  — Must meet the National Electric Code (NEC) for hazardous locations

• Interior wiring systems
  — Include provisions for grounding metal parts of electrical raceways, equipment, and enclosures

• Close unused openings with appropriate covers

• Electrical enclosures must be provided with tight-fitting covers or plates

• Do not bypass electrical safety interlocks

• Disconnect switches

• Safeguard conductive materials
Employee Responsibilities

Employees must

• Report hazards to life or property as soon as possible
• Make preliminary inspections
• Conduct appropriate tests to determine conditions before starting work on electrical equipment or lines
• Use appropriate electrical tools and equipment in wet areas
Employee Responsibilities

Employees must

- Maintain a clear 3 foot area surrounding all electrical equipment to permit ready and safe operations and maintenance
- Not work alone on energized lines or equipment over 600 volts
- Be instructed in CPR if they regularly work on or around energized electrical equipment