

Arc Flash Safety



Arcing Fault Events

- An arc is produced by flow of electrical current through ionized air after an initial flashover or short circuit.
- Arcs produce some of the highest temperatures known to occur on earth – up to 35,000 degrees F. This is four times the surface temperature of the sun.
- All known materials are vaporized at this temperature.

Arc Flash Effects

- Average of 1,710 (reported) electrical burns per year in USA
 - Burn from intense heat
 - Trauma from blast pressure
 - Toxic gases from vaporized metal
 - Sprayed molten metal droplets
 - Hearing damage from sound pressure wave
 - Eye damage













Electrical Safety Requirements

OSHA 1910.333 (a)(1) & NFPA 70E 130.1

Qualified electrical workers shall not be asked to work on equipment that is “hot” or “live” except for two reasons:

1. De-energizing introduces additional or increased hazards
 - ❑ Such as cutting ventilation to a hazardous location
2. Infeasible due to equipment design or operational limitations
 - ❑ Such as doing voltage testing for diagnostics

Elements of Arc Flash Safety

- Defined responsibilities
- Calculation of degree of arc flash hazard
- Personal protective equipment
- Training
- Tools for safe work
- Warning labels on equipment

Responsibilities

■ MSU will provide:

- PPE
- Training
- Labeling
- Insulated tools
- Lock out/tag out devices

■ MSU employee will:

- Follow safe work practices
- Use appropriate insulated tools
- Wear PPE when required

Arc Flash Hazard Analysis

- Determines flash protection boundary and PPE requirements as a function of location and work activity.
- Arc flash hazard and flash protection boundary varies with:
 - Type of equipment and configuration
 - Available short circuit current
 - Voltage
 - Predicted fault duration – protective devices upstream on the arcing fault and their settings

Flash Protection Boundary

- Linear distance from exposed live parts within which a person could receive second degree burns resulting from an arc flash.






Flash Protection Boundaries

- Limited Approach Boundary
 - Entered only by qualified persons or unqualified persons escorted by qualified person
- Restricted Approach Boundary
 - Entered only by qualified persons required to use shock protection techniques and equipment
- Prohibited Approach Boundary
 - Entered only by qualified persons requiring same protection as if in direct contact with live parts

Flash Protection Boundary (FPB)
Must wear appropriate PPE
FPB dependent on fault level and time duration.

Equipment

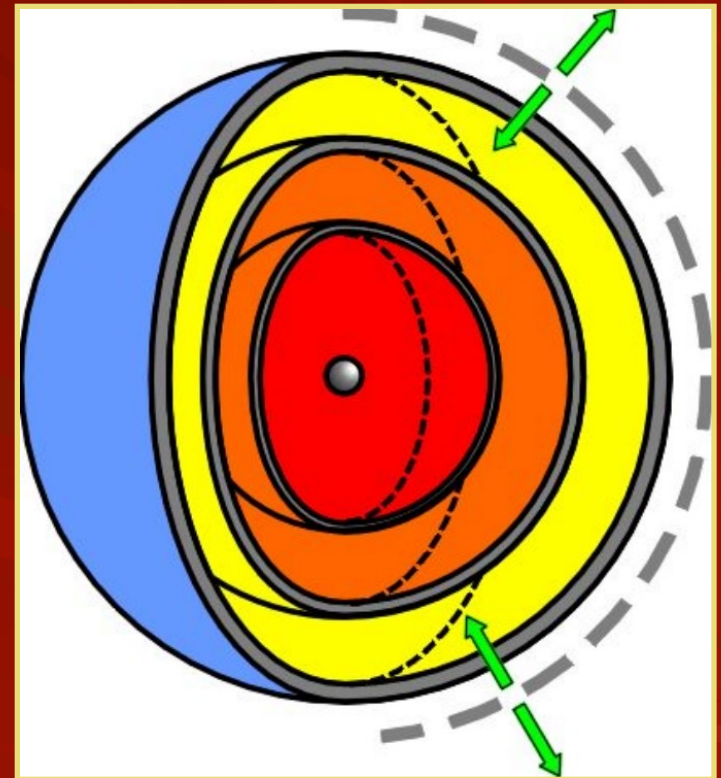


-  **Prohibited shock boundary:** Qualified persons only - PPE as if direct contact with live part
-  **Restricted shock boundary:** Qualified persons only
-  **Limited shock boundary:** Qualified or unqualified persons*
*only if accompanied by qualified person

Note: shock boundaries dependent on system voltage level

Approach Boundaries

- Each boundary is a sphere to be observed in all directions three dimensionally.



Labeling

- Switchboards, panel boards, industrial controls, etc. that require examination, adjustment, or maintenance while energized shall be labeled.

Labeling

- Labels shall be designed to warn of potential arc flash hazards
- MSU will classify arc flash hazard labels into two types:
 - Low voltage below 680 volts
 - High voltage above 680 volts



Insulated Tools

- Flame retardant
- Double insulated. A first hi-visibility yellow layer provides the insulation for the tool, and the outer hi-visibility orange layer protects the lower yellow layer.
- NOTE: If the yellow layer can be seen through the orange layer, the tool should be from service.



NFPA 70E 120.1

- 120.1 Process of Achieving an Electrically Safe Work Condition
 - An electrically safe work condition shall be achieved when performed in accordance with the procedures of 120.2 and verified by the following process:

Electrically Safe Work Condition

1. Determine all electrical sources using up-to-date information, drawings, diagrams, etc.
2. After properly interrupting the load current, open the disconnecting device(s) for each source.
 - At this point, the equipment or circuit is simply de-energized, not in an electrically safe work condition.

Electrically Safe Work Condition

3. Visually verify that disconnecting means fully open if possible
4. Apply lockout tagout devices
5. Test for absence of voltage
 - ❑ Verify proper operation of test equipment
6. Ground phase conductors if there is a possibility of induced voltages or stored energy



Electrically Safe Work Condition

- Until these six steps have been executed, some exposure to an electrical hazard still exists and proper PPE is required.



Safe Work Practices

- For open box work where the circuit can not be de-energized, safe work practices will include:
 - Use of insulated tools
 - Use of personal protective equipment
 - Not working alone

Safe Work Practices

■ If the box is open and the circuit can not be de-energized personal protective equipment is required; for 120 volts:

- Safety glasses
- Cotton shirt and pants

*Note: NFPA recommends cotton under garments for use when an arc flash hazard is present.

Safe Work Practices

- If the box is open and the circuit can not be de-energized, personal protective equipment is required; for 120-680 volts:
 - Safety glasses, ear plugs
 - Cotton shirt and Indura pants (MSU work uniform)
 - Category 2 face shield
 - Category 2 Indura coat
 - Low voltage insulated gloves



Safe Work Practices

- If the box is open and the circuit can not be de-energized, personal protective equipment is required, for high voltage of 680V or higher:
 - Safety glasses, ear plugs
 - Cotton shirt and Indura pants
 - Category 4 hood
 - Category 4 Indura coat and pants
 - High voltage insulated gloves with leather over gloves



PPE – NFPA 70E Table 130.7

Typical Protective Clothing Systems		
Hazard/Risk Category	Clothing Description (Typical number of clothing layers is given in parentheses)	Required Minimum Arc Rating of PPE [(J/cm ² (cal/cm ²)]
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd ² (1)	N/A
1	FR Shirt and FR pants or FR coverall (1)	16.74 (4)
2	Cotton underwear - conventional short sleeve and brief/shorts, plus FR shirt and FR pants (1 or 2)	33.47 (8)
3	Cotton underwear plus FR shirt and FR pants plus FR coverall, or cotton underwear plus two FR coveralls (2 or 3)	104.6 (25)
4	Cotton underwear plus FR shirt and FR pants plus multi-layer flash suit (3, or more)	167.36 (40)

Summary

- Equipment should be placed in an electrically safe work condition prior to servicing the equipment.
- Safe work practices should be followed to reduce the hazards associated with an arc flash.
- If necessary to work on live parts:
 - 120 volts - safety glasses & cotton uniform
 - 120-680 volts – Category 2 arc flash suit
 - 680 volts and above – Category 4 arc flash suit