Arc Flash → Blast

DMME

Division of Mineral Mining

AR Training

Updated 2012

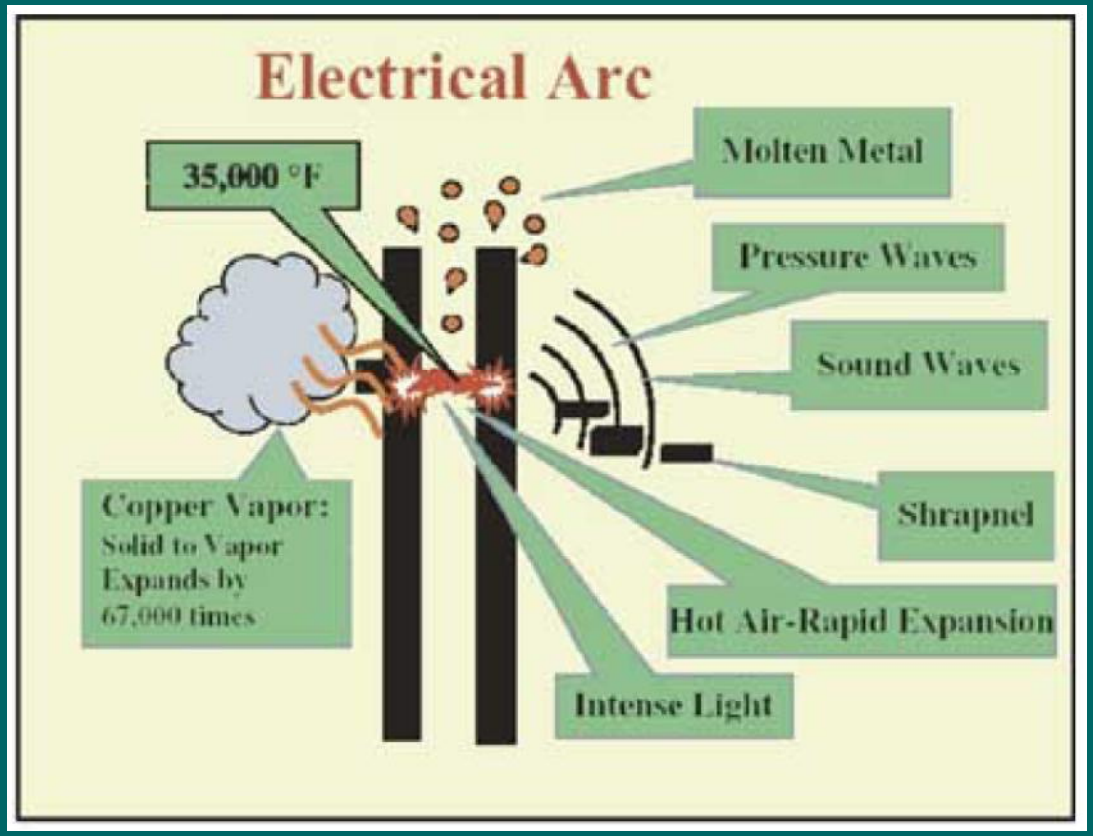
What Causes An Arc Flash?

- Getting too close to “live” components with conductive tools will result in an arc, as well as:
  - Movement of loose connections.
  - Dust/dirt/corrosion on components.
  - Damaged or deteriorated insulation.
  - Improper testing procedures or testing equipment use.
  - Water or vapor can create a path to ground.
- *Depending on the voltage and other factors, these arcs can produce temperatures up to 35,000 degrees!*

What Causes An Arc Blast?

- A flash creating temperatures up to 35,000 degrees will super heat the air as well as melt and/or vaporize the materials it contacts. *All known materials will vaporize at this temperature!*
- Air and materials exposed to this kind of heat expand very rapidly creating an explosive force or blast.
  - For example, when copper vaporizes it expands 67,000 times normal. Water 1,670 times.
  - In a confined space, such as an electrical cabinet, the blast is directed and magnified.

What Happens?



What Are The Effects?

- Obviously, these kinds of temperatures pose a severe burn hazard and the arc is a shock hazard.
- The flash/light can easily cause eye damage.
- Molten metal and shrapnel are spewed out at speeds reaching 700 miles per hour easily penetrating the human body.
- An arc blast creates a pressure wave that can reach 2,000 lbs./sq. ft. Noise can exceed 140 dB.
  - Ear drums can be damaged at 720 lbs./sq. ft.
  - 1,728 lbs./sq. ft. can result in lung damage.
  - A 170 lb. person can be thrown across a room at over 100 miles an hour.

When Is There A Danger?

- The danger is there only if current is. If work must be performed on or near energized parts, then NFPA (National Fire Protection Association) publication 70E should be your guide.
- According to NFPA 70E:
  - Circuits carrying less than 50 volts present little or no danger.
  - Up to 240 volts served by a single transformer of less than 125 Kva, the danger is minimal.
  - If the circuit is above 240 volts and/or served by more than one transformer larger than 125 Kva, then a significant hazard may exist.

How Can The Danger Be Avoided?

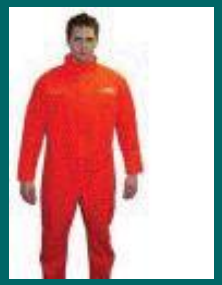
- The easy answer is don't allow any work to be done "live" or in proximity to "live" components. Post and enforce a strict de-energize and lockout policy per NFPA 70E.
- If the possibility of "live work" exists, then an arc flash analysis should be done on all subject installations.
  - This analysis should be done by a competent engineer using guidance from NFPA 70E and IEEE (Institute of Electrical and Electronic Engineers) Standard 1584.

What Will Analysis Tell Us?

- One key result will be to identify the “incident energy” level that could be expected in an arc flash event at a specific electrical installation. The incident energy level provided by the study will be given in calories per centimeter squared (cal/cm2).
  - Incident energy is defined in NFPA 70E as, “the amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event”.
  - A calorie is a measure of heat energy.
- The calories/cm2 provided by the study will be reviewed to determine what level of PPE is required, among other things.

How Do We Choose PPE?

- NFPA 70E contains 5 hazard risk categories (HRC), 0 through 4.
  - The categories relate to cal/cm2 levels or the ATPV (arc thermal performance value) rating assigned to clothing and other items.
  - The ATPV rating is based on the cal/cm2 that will cause a second degree burn. 1.2 cal/cm2 is the threshold for second degree burns.
  - Clothing, face shields, gloves, etc. should be selected based on the HRC or ATPV rating assigned by the manufacturer.
- The chart on the next slide shows the HRC's and associated ATPV's and describes the clothing requirements.
- Note that 40 cal/cm2 is the highest level on the chart. No PPE presently available offers protection above 40 cal/cm2. ***Work should not be done "live" if this level may be exceeded!!***



Hazard/Risk Category	Clothing Description	ATPV Rating Cal/cm^2
0	Untreated Cotton, Wool, Rayon, Silk, or Blend. Fabric weight >4.5oz/Yd^2 (1 layer)	N/A
1	FR* Shirt and FR Pants or FR Coverall (1 layer)	4
2	Cotton underwear plus FR shirt and FR pants (1 or 2 layers)	8
3	Cotton underwear plus FR shirt and FR pants plus FR coverall, cotton underwear plus two FR Coveralls (2 or 3 layers)	25
4	Cotton underwear plus FR shirt and FR pants plus multilayer flash suit (3 or more layers)	40

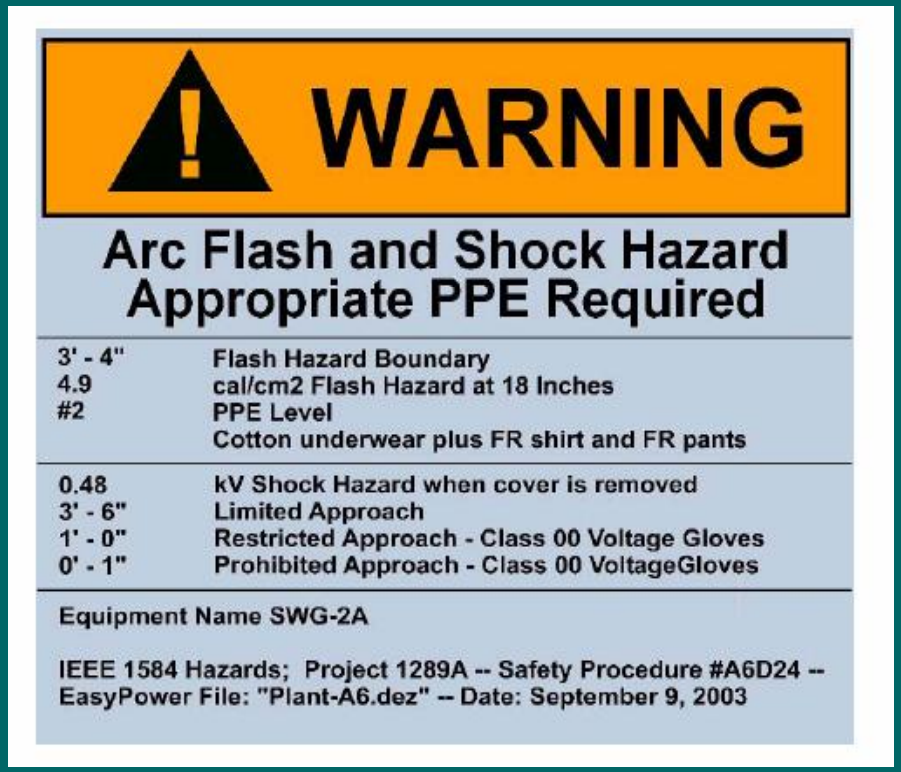
* FR = fire resistant

Other Analysis Information

- As required in NFPA 70E under “Safety Practices When Working Live”:
  - Determine Shock Hazard Boundaries (3):
    - Limited Approach Boundary.
      - Entered if accompanied by a qualified person.
    - Restricted Approach Boundary.
      - Entered only by a qualified person.
    - Prohibited Approach Boundary.
      - Entered only by qualified person with precautions taken for live part contact.
    - These boundaries determine when voltage rated gloves and tools must be used.
  - Determine Flash Protection Boundary.
    - Entered by qualified person wearing appropriate PPE; arc flash – arc blast clothing and equipment.
    - This boundary usually ranges from 4 to 20 feet.
      - The default boundary for systems operating at 600 volts is 48 inches.

Actions Based On Analysis

- If “live work” is to be allowed:
  - Label enclosures with the appropriate ‘boundary” information.
  - Make sure appropriate PPE and tools are available.
  - Make sure personnel are properly trained.
  - NFPA 70E recommends a written live work permit program.
- If live work is not allowed; label enclosures, and post MCC buildings to that effect. Train personnel accordingly.
- Remember, entering an energized enclosure, even for testing purposes, with no intention of touching live components is in fact “live work”.



Summary

- Policies and procedures must be in place governing “live work”:
  - The best policy is no “live work”.
    - Remember, any access, even for testing, is “live work”.
  - Post your policy and train your people.
  - If “live work” may be necessary:
    - Determine the level of danger and the various “boundaries”.
    - Post/label equipment with specific information.
    - Ensure that proper procedures are followed, proper PPE and tools are available and used.
- Even with proper PPE, severe injury may result from the force of the pressure wave and shrapnel.
- *Never allow, or perform, “live work” where the capability of available PPE might be exceeded.*

NIOSH Film

25 minutes

Access film: http://www.msha.gov/streaming/wvx/arcflash.wvx