



Arc Flash Basics and Hazard Planning Program

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ARC FLASH BASICS AND HAZARD PLANNING PROGRAM

This course gives an overview of arc flash hazards and concisely reports the different causes, nature, findings, directions and processes related with arc flash hazards. In order to address the hazard, it is first required to formulate an understanding of the process. Points are given in the next sections.

An electric arc or an arcing fault is a flashover of electric current through air in electrical devices from one exposed live conductor to another or to ground. Arc flash hazard is the risk of excessive heat exposure and severe burn hurt due to arcing faults in electrical systems. Electric arcs generate intense heat, sound blast and pressure waves. They have really high temperatures, radiate acute heat, can inflame clothes and induce serious injuries that can be fateful.

The requirement for uninterrupted supply of power has lead about the requirement for electrical staff to complete maintenance jobs on exposed live parts of electrical devices. Apart from the existence of electrical shock incidents that results from direct contact of live conductors with body parts, there also exists a probability of electric arcs hitting across live conductors. Even though electrical safety procedures have existed since the beginning of electricity, arc flash hazard has not been conspicuously treated until recently.

ELECTRIC ARC CAUSES

Arcs can be started by the following:

- Glow to arc discharge
- Dust and impureness: Dust and impureness on insulating areas can give a path for current, allowing it to flashover and start arc discharge across the surface. This can grow into bigger arcs. Fumes or vapor of chemicals can decrease the breakdown voltage of air and induce arc flash.

- Corrosion: Corrosion of device elements can leave impureness on insulating areas. Corrosion also breaks the contact between conductor terminals, enhancing the contact resistance through oxidation or different corrosive pollution. Heat is produced on the contacts and sparks may be generated, this can head to arcing faults with nearby exposed conductors of different phase or ground.
- Condensation of vapour and water dropping can induce tracking on the coat of insulating materials. This can induce a flashover to ground and possible increase to phase to phase arcing.
- Spark discharge:
- Incident touching: Incidental contact with live exposed elements can start arc faults.
- Dropping tools: Incidental dropping of tools may induce momentary short circuit, generate sparks and start arcs.
- Over-voltages across narrow gaps: When air gap between conductors of various phases is very narrow (due to poor craftsmanship or damage of insulating materials), arcs may hit across during over-voltages.
- Break down of insulating materials. Electric arcs are also induced by the following:
 - o Improperly made or used devices.
 - o Wrong work processes.



ELECTRICAL ARC NATURE

Electric arcs generate some of the greatest temperatures known to exist on earth – up to 35,000 degrees Fahrenheit. This is four times the surface temperature of the Sun.

- The acute heat from arc induces the fast expansion of air. This ends in a blow with very strong air pressure (Lightning is a natural arc). All known materials are vaporized at this temperature. When materials vaporize they expand in volume (Copper – 67,000 times, Water–1670 times). The air blow can spray molten metal to far distances with great force.
- For a low voltage system (480/277 V), a 3 to 4-inch arc can turn “stabilized” and exist for a prolonged period.
- Energy discharged is a function of system voltage, fault current magnitude and fault duration.
- Arcs in enclosures, such as a Motor Control Center (MCC) or switchgear, amplify blow and energy transferred as the blow is pushed to the open side of the enclosure and toward the staff.

ARCING FAULTS HAZARDS

Some of the arcing faults hazards are:

- Heat: Fateful injuries can happen when staff is few feet from the arc. Dangerous injuries are frequent at a distance of 10 feet. Completed experiments have recorded temperatures higher than 437°F on the neck area and hands for a person standing close to an arc blast.
- Objects: Arcs spray drops of molten metal at high-speed pressure. Blast shell can enter the body.

- Pressure: Blast pressure waves have thrown staff across rooms and knocked them off ladders. Pressure on the chest can be greater than 2000 lbs/sq.ft.

Clothing can be combusted few feet away. Clothed areas can be combusted more badly than exposed skin.

- Hearing loss from sound blow. The sound can have a magnitude as high as 140 dB at a distance of 2 feet from the arc.

SURVIVAL PROBABILITY

Traumas due to arc flash are known to be very serious. According to statistics from the American Burn Association, the chance of survival diminishes with the increasing age of the arc flash burn victim.

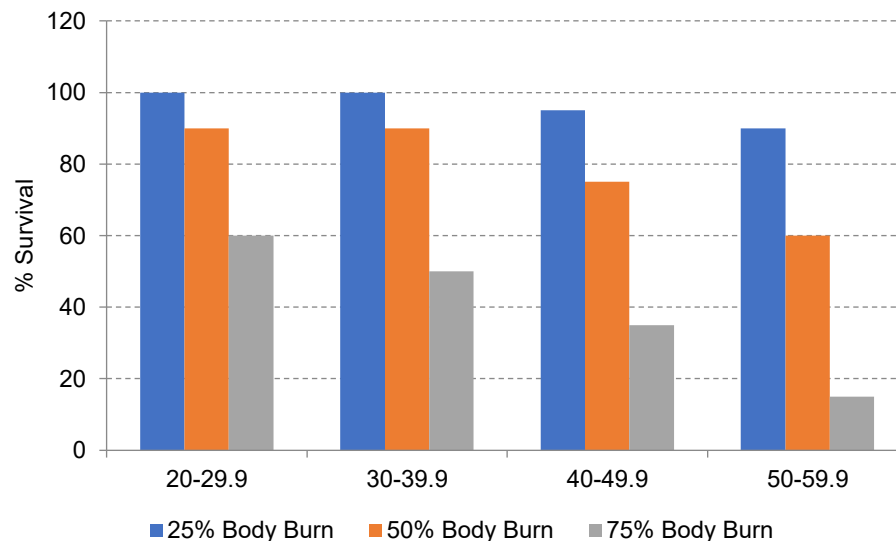


Figure 1. Burn injury statistics – probability of survival (source: American Burn Association, 1991-1993 Study; Revised March 2002)



ARC FLASH IMPACT

Treatment may need years of skin grafting and rehabilitation. The victim may never go back to duties or keep the same life quality. Some of the direct expenses are:

- Treatment can surpass \$1,000,000/case.
- Litigation costs
- Manufacturing loss

ARC FLASH POTENTIAL EXPOSURE

Even though it may seem that arc flash occurrences are unusual, statistics imply that the harm they make is significant. Bureau of Labor Statistics information for 1994 indicated 11,153 cases of accounted days away from job due to electrical burns, electrocution/electrical shock injuries, fires and blasts. The Census of Fatal Injuries acknowledged 548 employees died from the causes of electrical current exposure, fires and blasts of 6,588 work associated fatalities around US. In the US Chemical Industry, 56% of the fatalities that happened over a 5-year period were assigned to burns, fires and blasts, with many of the firing sources being associated to electrical activity.

It was reported that there are 5 to 10 arc flash injuries per day leading to hospitalization. Many arc flash incidents/injuries happen that do not need a stay or are not adequately reported for national tracking needs. The number of arc flash incidents is higher than many engineers actualize since most arc flash incidents do not reach the daily news. IEEE Standard 1584, IEEE Guide for Performing Arc Flash Hazard Calculations, presents arc flash injury case histories. An abbreviated description is given for each situation on accident setting, electric system, devices, staff activity, event, clothes worn by the staff and the results of the accident. Readers are recommended to read these scenarios to get insights on different circumstances leading to such accidents.



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