NFPA 70E: Performing the Electrical Flash Hazard Analysis

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On June 11, 1999, an electrician was trouble-shooting the emergency power system. After testing the transfer panel, he moved to the emergency breaker compartment (480 volts, 200 amps), removed the cover panel, and proceeded to test the circuits. Initial testing showed power on all terminals. When the electrician started to test the circuits again, a fault occurred, resulting in the formation of a fireball seriously injuring the Assistant Building Engineer and fatally injuring the Assistant Fire Chief and electrician [Source: National Institute for Occupational Safety and Health (NIOSH)]

The preceding incident is an example of the hazards associated with an electric arc flash. An electric arc flash, which is a short circuit through the air, occurs when an employee is working on or near energized electrical equipment and inadvertently contacts conductors or circuits, such as dropping a part or tool, resulting in a phase-to-ground, or a phase-to-phase fault. Also, equipment malfunction may produce a spark or arc, resulting in an arcing fault.

The Hazards of Electric Arc Flashes

Approximately 80% of all electrical injuries are burns resulting from the electric arc flash and ignition of an employees’ flammable clothing. Arc flashes cause electrical equipment to explode, resulting in an arc-plasma fireball. Temperatures may exceed 35,000° F (the surface of the sun is 9000° F). These high temperatures cause rapid heating of surrounding air and extreme pressures, resulting in an arc blast. The arc blast will likely vaporize all solid copper conductors; solid copper expands to 67,000 times its original volume when it is vaporized. In addition, measurements taken on a test mannequin during a laboratory arc flash detected sound levels of 141.5 decibels at two (2) feet from the blast, and pressure levels of 2,160 pounds per square foot (psf) in the immediate vicinity of the blast.

An electric arc flash can ignite an employees’ flammable clothing causing severe burns; the intense light of an arc flash can cause cataracts; the tremendous sound pressure may damage an employees hearing; and the pressure levels could knock an employee down. Also, flying shrapnel could result in serious injury, or death.

Prevention of Arc Flash Incidents

By far, the best way to prevent an electric arc flash is to always deenergize and lockout/tagout all electrical equipment prior to performing servicing and maintenance activities. OSHA 29 CFR 1910.333 (a)(1) states: “...Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them, unless the employer can demonstrate that deenergizing 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 deenergized if there will be no increased exposure to electrical burns or explosion due to electric arcs.”

Some examples of increased or additional hazards may include: interruption of life support equipment, deactivation of emergency alarm systems, atmospheric monitoring equipment, or shutdown of hazardous ventilation equipment. Examples where it may be infeasible to deenergize equipment include performing diagnostics and testing (e.g., start-up or troubleshooting) that can only be performed with the circuit energized.

Electrical Safety-Related Work Practices

If electrical equipment must remain energized while servicing and maintenance is performed, electrical safety-related work practices must be utilized by qualified employees as outlined by OSHA in 29 CFR 1910.331 – 1910.335. In addition to OSHA’s requirements, NFPA 70E Standard for Electrical Safety in the Workplace (2004 Edition) contains requirements for performing a flash hazard analysis.

Flash Hazard Analysis and Flash Protection Boundary

Prior to commencing work on electrically energized conductors ≥ 50 volts, NFPA 70E Article 130.3 requires a flash hazard analysis be performed to identify work tasks that must be performed while electrical equipment remains energized. Instead of performing a detailed analysis, however, Table 130.7 (C)(9)(a) (Hazard Risk
Category Classifications) may be utilized to identify various job tasks and the corresponding hazard risk category.

NFPA 70E Article 130.3 (A) requires employers to establish a flash protection boundary – a distance from exposed energized electrical parts at which an employee could sustain a second degree burn if an electric arc flash were to occur. Employees performing work on energized conductors inside this boundary must be protected with appropriate Personal Protective Equipment (PPE). In most cases, the flash protection boundary for electrical systems 600 volts and below will be four (4) feet.

**Selection of Personal Protective Equipment**

NFPA 70E Table 130.7 (C)(9)(a) lists various work tasks and the corresponding hazard risk category (0 through 4). Once the hazard risk category has been determined, Table 130.7 (C)(10) [Protective Clothing and Personal Protective Equipment (PPE) Matrix] is consulted to determine the appropriate PPE. An example is listed below.

**Example:** Employee is working on an energized panelboard (including voltage testing) rated ≤ 240 volts. **Required PPE:** Task is listed as a hazard risk category one (1). In addition to voltage rated gloves, Table 130.7 (C)(10) specifies the following PPE: Flame retardant clothing (long-sleeve shirt and pants), hard hat and safety glasses.

**Arc Flash Marking on Field Breakers**

In addition to the flash hazard analysis and PPE requirements specified in NFPA 70E, the 2002 National Electrical Code® (NEC) requires field labeling of circuit breaker panels and electrical disconnects to warn qualified employees of the potential arc flash hazards:

**Article 110.16 Flash Protection:** “Switchboards, panelboards, industrial control panels, and motor control centers in other than dwelling occupancies, that are likely to require examination, adjustment, servicing, or maintenance while energized, shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.” An example of an arc flash label is shown below.

![Photo: Author’s collection](image)

**Summary**

Arc flash hazards pose a serious risk to employee safety; proper safe work practices must be utilized. Electrical equipment ≥ 50 volts must be deenergized and lockout/tagout followed prior to servicing and maintenance unless doing so would increase hazards or is infeasible. Remember, convenience is not an acceptable reason for keeping equipment energized during servicing and maintenance. If electrical equipment must remain energized during servicing and maintenance, NFPA 70E should be consulted to determine flash hazard boundaries as well as required PPE. Finally, circuit breakers and electrical disconnects must be marked to warn qualified employees of potential arc flash hazards.

*If you have any questions concerning this article or other safety issues, please contact W. Jon Wallace at 919.943.5548 or email: jwallace@workplacegroup.net.*