

Arc Flash Safety: History and Requirements

History and Awareness

Arc flash was first identified by Dr. Ralph Lee in his 1982 "[The Other Electrical Hazard: Electric Arc Blast Burns](#)." Dr. Lee found that as many as 80% of electrical injuries resulted from arc flash rather than from shock, which had always been thought to be the major risk associated with live electrical work.

By 1990 the threat of arc flash was well established, and OSHA updated 29 CFR 1910 Subpart S to recognize the need for arc flash safety. NFPA 70E, the Electrical Safety Workplace Standard, was revised to include the calculations necessary to establish arc flash protection boundaries, and equipment manufacturers began to offer arc-resistant switchgear as a means to minimize arc flash hazards.

The first requirement for arc flash warning labels appeared in the 2002 revision of [NFPA 70](#), the National Electric Code. That same year [IEEE](#) introduced its [Standard 1584](#), providing guidelines for conducting an arc flash hazard analysis, considered by many to be a much more accurate and quantitative measure of hazards than NFPA 70 alone.

How it happens

An arc is produced by flow of electrical current through ionized air after an initial flashover or a short circuit. The NFPA describes an arc flash as occurring "when an electric current passes through air between ungrounded conductors or between ungrounded conductors and grounded conductors." The event releases a tremendous amount of energy in the form of thermal heat, toxic fumes, pressure waves, blinding light, sound waves and explosions that can result in serious injury including critical burns, collapsed lungs, loss of sight, ruptured eardrums, puncture wounds and even death.

Accidents, unintentional contact with electrical equipment systems, equipment failure, improperly designed equipment and/or work procedures can all cause an arc flash explosion, producing heat of up to 35,000 degrees Fahrenheit, about four times the surface temperature of the sun. Air and metal in the path of the arc expand and explode, and can cause fatal burns up to five feet from the arc and severe burns up to ten feet away.

Regulatory status and applicability

29 CFR 1910 Subpart S and 1926 Subpart K incorporate by reference NFPA 70E. OSHA allows work on live electrical parts under only two special circumstances: (1) when continuity of service is required, and (2) when de-energizing equipment would create additional hazards. In all other cases, lockout/tagout applies. If it is necessary and allowed to work "hot" (>50 volts to ground), NFPA 70E - Article 130 is the reference for compliance with [29 CFR 1910.333\(a\)\(1\)](#), including shock hazard analysis, voltage to

which personnel will be exposed, boundary requirements, flash hazard analysis, determination of flash protection boundary and PPE needed within that boundary.

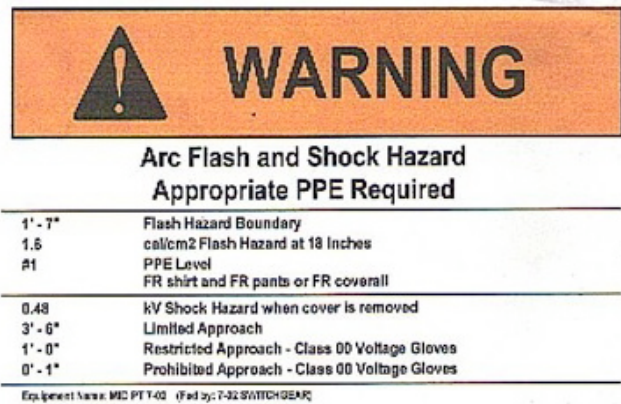
Can you be cited for not complying with NFPA 70E?

Yes. The employer must assess the workplace for electrical hazards and the need for PPE under 29 CFR 1910.335(a)(1)(i). How to comply with this standard is up to the employer, but you are expected to use the best means available to comply with this requirement. Using only NFPA 70E might satisfy the minimum OSHA requirements, but may not adequately quantify arc flash hazards. In the event of an injury or death due to an electrical accident, if OSHA determines that compliance with 70E would have prevented or lessened the injury, they may cite the employer under the general duty clause. In a [2003 interpretation letter](#) OSHA indicated that 70E could be used to determine whether the employer acted reasonably. They are in the process of adopting NFPA 70E documents to address both shock and arc flash hazards, and will cite NFPA 70E in accident investigations and fines assessment.

Labels for affected equipment

OSHA has no specific requirement for arc hazard labels. However, in a [2006 interpretation letter](#) OSHA states “*paragraph (e) of §1910.303 requires employers to mark electrical equipment with descriptive markings, including the equipment's voltage, current, wattage, or other ratings as necessary. OSHA believes that this information, along with the training requirements for qualified persons, will provide employees the necessary information to protect themselves from arc-flash hazards. Additionally, in §1910.335(b), OSHA requires employers to use alerting techniques (safety signs and tags, barricades, and attendants) . . . to warn and protect employees from hazards which could cause injury due to electric shock, burns or failure of electric equipment parts. Although these Subpart S electrical provisions do not specifically require that electric equipment be marked to warn qualified persons of arc-flash hazards, §1910.335(b)(1) requires the use of safety signs, safety symbols, or accident prevention tags to warn employees about electrical hazards (e.g., electric-arc-flash hazards) which may endanger them as required by §1910.145.*”

Switchboards, panel boards, industrial control panels, and motor control centers must be field-marked, and equipment installed after 2002 must be labeled. Equipment installed before 2002 must be labeled if any modifications or upgrades are done.



WARNING

Arc Flash and Shock Hazard
Appropriate PPE Required

1' - 7"	Flash Hazard Boundary
1.5	cal/cm ² Flash Hazard at 18 Inches
#1	PPE Level
	FR shirt and FR pants or FR coverall
0.48	kV Shock Hazard when cover is removed
3' - 6"	Limited Approach
1' - 0"	Restricted Approach - Class 00 Voltage Gloves
0' - 1"	Prohibited Approach - Class 00 Voltage Gloves

Equipment Name: MDC PT 1-02 (Fed by: 7-02 SWITCHGEAR)

The bottom line

The burden is on employers to provide the training, equipment, labeling, personal protective equipment and work rules that let workers perform safely in situations where arcs might occur. Qualified persons must make the necessary calculations and apply very specific recommendations that will protect workers. In many cases, the expertise to do this is not available in-house. If conducted properly, a qualified person must evaluate the incoming current from the utility provider, transformers, switchgear, disconnect devices, wire size, length of wire, trip devices, trip settings, and end load to properly evaluate each electrical device for the correct arc flash determination, appropriate boundary distances and the appropriate PPE for each location. Insist on a current one-line drawing and labels for the location being studied and site-specific training for employees.

Arc flash injures and kills, and OSHA will cite you for lack of compliance with NFPA 70E and related requirements. This is complex work, and the employer is advised to be selective in their methods and the consultant or in-house expert(s) they trust with this program.

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