

## FOCUS ON PROTECTIVE APPAREL

**O**n June 11, 1999, an electrician was troubleshooting 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 that seriously injured the assistant building engineer and fatally injured the assistant fire chief and electrician. [Source: National Institute for Occupational Safety and Health]

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 by 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.

# NFPA 70E: PERFORMING THE ELECTRICAL FLASH HAZARD ANALYSIS

**Remember, convenience is not an acceptable reason for keeping equipment energized during servicing and maintenance.**

*by W. Jon Wallace*



## The Hazards of Electric Arc Flashes

Approximately 80 percent of all electrical injuries are burns that result from the electric arc flash and ignition of an employee's flammable clothing. Arc flashes cause electrical equipment to explode, resulting in an arc-plasma fireball. Temperatures may exceed 35,000 degrees F (the surface of the sun is 9,000 degrees F). These high temperatures cause rapid heating of surrounding air and extreme pressures, resulting in an arc blast. The arc blast probably will 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 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 employee's flammable clothing, causing severe burns; the intense light of an arc flash can cause cataracts; the tremendous sound pressure may damage an employee's hearing; and the pressure levels could knock an employee down. Also, flying shrapnel could result in serious injury or death.

## Preventing Arc Flash Incidents

By far, the best way to prevent an electric arc flash is always to deenergize and to lock out/tag out all electrical equipment prior to performing servicing and maintenance activities. OSHA's 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 or atmospheric monitoring equipment, or shutdown of hazardous ventilation equipment. An ex-

ample where it may be infeasible to deenergize equipment would be performing diagnostics and testing (e.g., startup 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 through 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.

The National Electrical Code® is generally considered an electrical installation document, and it protects employees under normal circumstances. However, it does not address electrical safety-related work practices. In an effort to protect employees while working on or in the vicinity of electrical equipment, OSHA asked the National Fire Protection Association to develop a standard addressing electrical safe work practices. In response, the first edition of NFPA 70E was published in 1979. NFPA 70E is intended to provide guidance with respect to electrical safe work practices.

## OSHA and NFPA 70E

Does OSHA enforce NFPA 70E? No, NFPA 70E is not incorporated by reference in 29 CFR 1910.6. However, OSHA has several comparable requirements that are enforceable:

- 29 CFR 1910.132 (d)(1): Requires employers to perform a personal protective equipment (PPE) hazard assessment to determine necessary PPE.
- 29 CFR 1910.269 (l)(6)(iii): Requires employers to ensure each employee working at electric power generation, transmission, and distribution facilities who is exposed to the hazards of flames or electric arcs does not wear clothing that could increase the extent of injury when exposed to such a hazard.
- 29 CFR 1910.335 (a)(1)(i): Employees working in areas where there are potential electrical hazards shall use electrical protective equipment appropriate for the specific parts of the body for the work being performed.
- 29 CFR 1910.335 (a)(1)(iv): Requires that employees wear nonconductive head protection whenever exposed to electric shock or burns due to contact with exposed energized parts.
- 29 CFR 1910.335 (a)(1)(v): Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes

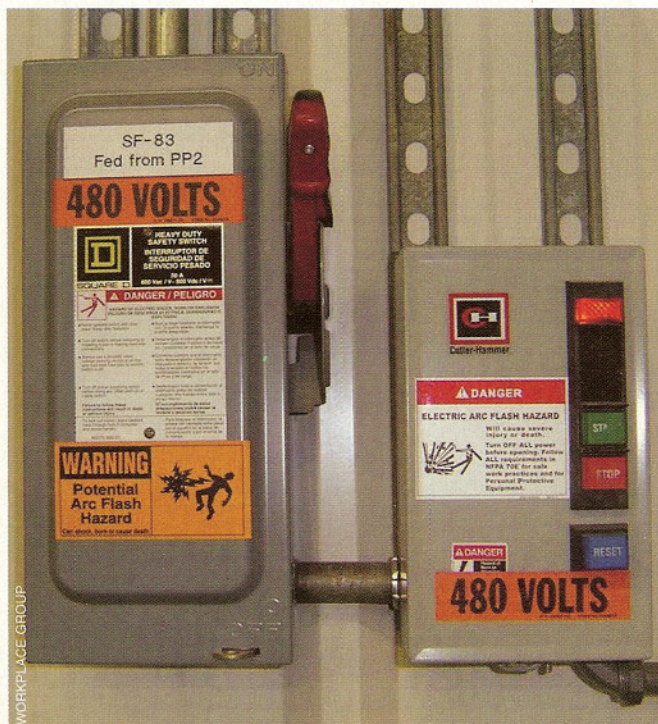
or from flying objects resulting from an electrical explosion.

- 29 CFR 1910.335 (a)(2): Employees shall use insulated tools or handling equipment when working near exposed energized conductors or circuit parts.
- 29 CFR 1926.28 (a): Employer shall require employees to wear appropriate personal protective equipment (PPE) during construction work.

## Flash Hazard Analysis and Flash Protection Boundary

Prior to commencing work on electrically energized conductors greater than or equal to 50 volts, NFPA 70E Article 130.3 requires that a flash hazard analysis be performed to identify work tasks that must be performed while electrical equipment remains energized.

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## Protective Garments

COMPANY	BRAND/MODEL	ITEM	MATERIAL	WEIGHT	SIZES	LEVELS	REUSABLE	DISPOSABLE	RESISTANCE	SPLASH	CHEMICAL	HEAT/FLAME	SPECIAL FEATURES
Tingley Rubber Corp. Circle 115 on card	ElectraBrite	Jacket, overall, coat	PVC/Nomex®/Kevlar®	11 oz.	S-5XL		■	■	■	■	■	■	Fluorescent lime yellow
	Electra	Jacket, overall, coat	PVC/Nomex®	9 oz.	S-5XL		■	■	■	■	■	■	ASTM F 1891 compliant
	Comfort-Brite	Jacket, overall, coat	PVC/polyester	8 oz.	S-5XL		■	■	■	■	■	■	ANSI 107 compliant
	Safetyflex	Jacket, overall, coverall	PVC/polyester/PVC	12 oz.	S-4XL		■	■	■	■	■	■	Safety green, hidden hardware
	Magnaprene	Jacket, overall	Neoprene on nylon	9 oz.	S-4XL		■	■	■	■	■	■	Yellow exterior neoprene coating
Vidaro Corp. Circle 116 on card	C-3101-3	Coverall	Poly herringbone	4 oz.	S-3XL		■	■	■	■	■	■	
	C-3158-7	Coverall	Poly B-Fore	3 oz.	S-3XL		■	■	■	■	■	■	
	L-3117-6	Lab coat	Vi-Gard I	5 oz.	XS-3XL		■	■	■	■	■	■	
	C-4325-20	Coverall	Indura®	9 oz.	S-3XL		■	■	■	■	■	■	
	C-3043A-20	Coverall	Nomex®	6 oz.	S-3XL		■	■	■	■	■	■	
Warwick Mills Circle 117 on card	TurtleSkin WaterArmor	Suit	TurtleSkin aramid	13 lbs.	1 size fits all		■	■	■	■	■	■	For UHP water jetting; protects upper body, legs
	TurtleSkin WaterArmor	Gauntlets	TurtleSkin aramid	3 lbs.	1 size fits all		■	■	■	■	■	■	For UHP water jetting; protects forearms, back of hands
	TurtleSkin WaterArmor	Gaiters	TurtleSkin aramid	5 lbs.	1 size fits all		■	■	■	■	■	■	For UHP water jetting; protects feet, shins
	TurtleSkin SnakeArmor Chaps	Chaps	TurtleSkin polyester	28 oz.	Husky, regular; lengths: short, regular, tall		■	■	■	■	■	■	Lightweight, cool
	TurtleSkin SnakeArmor	Gaiters	TurtleSkin polyester	11 oz.	1 size fits all		■	■	■	■	■	■	Lightweight, cool

This is only a partial listing. For complete product information, circle the appropriate number on the reader service card at page 3.

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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. In most cases, the flash protection boundary for electrical systems 600 volts and below will be 4 feet.

### PPE Selection

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 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  $\leq$  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-sleeved 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 in the photograph accompanying this article.

### Summary

Arc flash hazards pose a serious risk to employee safety; proper safe work practices must be utilized. Electrical equipment  $\geq$  50 volts must be deenergized and locked out/tagged out 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. ■

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