

Avoiding incidents and investigations through prevention and protection

When an arc flash occurs, an enormous amount of concentrated energy explodes outward from the point of origin. There is an immediate high-intensity flash, which could cause vision damage or blindness. Temperatures within the arc can reach 35,000 °F (19,426 °C); the resulting thermal exposure can cause severe burns. The pressure wave from the blast can reach 200 lb/in². Workers can be knocked down or thrown several feet, resulting in broken bones, internal injuries, or hearing loss. Copper conductors vaporize. Material that isn't vaporized becomes shrapnel, which can cause punctures and lacerations. Some arc flash injuries result in death.



Damage from an arc blast

Understanding arc flash risks requires knowing the data. "Arc flash occurs five to 10 times a day in the US," said Joe Weigel, product manager for Square D Services at Schneider Electric. "Major injuries can be as serious as third- or fourth-degree burns. The average cost just for medical treatment is about \$1.5 million. The total cost including litigation can easily be \$8 million to \$10 million, and in some cases even higher. There's an average of about one fatality from arc flash per day."

Photos courtesy of DuPont™

Investigating the incident

If there is a serious industrial arc flash incident, the United States Department of Labor Occupational Safety & Health Administration (OSHA) will investigate. It will ask for the employer's electrical safety training records and arc flash hazard assessment. If the employer is found negligent in either of these areas, OSHA could impose a significant fine. However, if the incident involves injuries or loss of life and the worker's family chooses to sue, the employer's situation could become much worse.

The family's attorney must prove that an employer acted negligently or inappropriately. To build a credible case, many times attorneys rely on the testimony of expert witnesses. Based on forensic evidence from incident investigations, these experts can usually re-create the conditions that brought the incident about.

Typically these investigators are electrical engineers with many years of field experience. They are well-versed in electrical power issues, and fully understand why electrical incidents occur. Many are consultants who, as part of their primary career, help companies comply with the codes and standards that can prevent these incidents.

Generally the investigator conducts an incident analysis to gather facts. Usually this analysis involves reviewing documentation, inspecting the incident scene, interviewing witnesses, and evaluating these facts to determine the incident-causing factors. This can be quite complex because incidents frequently involve a sequence of events, and sometimes there are multiple contributing sequences.

Application Note

The preliminary investigation is the first phase of the analysis to determine exactly what happened and if there's enough evidence to warrant deeper analysis. If a deeper analysis takes place it will be to ascertain why the incident happened. These results provide evidence (if any) that the attorney can use during litigation.

Prevention and protection

These types of serious situations can be avoided. Information about preventing arc flash occurrences is becoming increasingly abundant. For nearly 10 years, trade publications, manufacturers, consultants, and electrical training organizations have provided a tremendous amount of information about arc flash. A growing industry has been built around companies providing arc flash hazard analysis, training, personal protective equipment (PPE), and arc mitigating equipment.

NFPA 70E: Standards for Electrical Safety in the Workplace provides the most comprehensive guidance for protecting workers from electric shock and arc flash hazards. The latest version is the 2012 edition. Although the greatest need for PPE focuses on arc flash, NFPA 70E also addresses shock and electrocution hazards. For example, PPE for shock and electrocution hazards includes insulated gloves, which are required in addition to leather gloves.

According to H. Landis "Lanny" Floyd, principal consultant for electrical safety and technology at DuPont Engineering, "A very important revision to the 2009 Edition of NFPA 70E is the addition of a fine-print note in section 110.7 that references *ANSI Z10-2005, Occupational Health and Safety Management*

Systems, which provides a hierarchy of hazard control measures applicable to any hazard in the workplace.”

This hierarchy of hazard control measures in ANSI Z10, according to Floyd, includes:

1. Elimination of the hazard
2. Substitution of less hazardous equipment or materials
3. Engineering controls to reduce exposure or severity
4. Warnings, signs, and other communications
5. Administrative controls, including safe work practices
6. Personal protective equipment

“The first five hazard control measures serve to help prevent an electrical incident,” Floyd said. “The last control measure—the application of [PPE]—serves to minimize injury to the worker if the other control measures have failed to prevent an incident.”

Using PPE is a critical element of any safety program designed to minimize arc flash hazards in the workplace. However, as Floyd points out, “It should not be the only control measure. Arc flash PPE works in conjunction with the other control measures to minimize injury severity in the event of an arc flash incident. In order for the PPE to perform effectively, its arc thermal performance rating must meet—or exceed—the thermal energy transfer during the arc flash incident. The best way to predict the thermal energy transfer, or incident energy, is to have performed an arc flash hazard analysis. PPE clothing and accessories can then be selected on performance rating, and matched to the predicted energy exposure.”

Hazard Risk Categories are based on incident energy, not voltage levels. The table lists the Hazard Risk Categories, the level of protection in cal/cm², and the differences in PPE requirements for each category. All categories require a long-sleeve shirt, safety glasses, leather gloves,

and leather work boots. Hearing protection is required for all categories as well. However, hearing protection must be inserts for Hazard Risk Categories I through IV because ear muffs could melt. Also required for Hazard Risk Categories I through IV are arc-rated face shields and voltage-rated gloves. Hard hats are required for Categories I and II only because Category 0 represents less incident energy and Categories III and IV require arc flash suits with hoods. Hazard Risk Category II now has a provision that allows either an arc-rated arc flash suit hood or a face shield with a minimum arc rating of 8 cal/cm² and balaclava.

Most electrical workers are between the ages of 30 and 50. Most of them have families that expect them to come home safely each day. There’s too much at stake to take shortcuts. Taking steps to prevent arc flash incidents can minimize occurrences. Wearing and using appropriate PPE will reduce your injuries and could save your life.

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Hazard risk categories

Hazard risk category	Work Wear Description	Arc Rating (cal/cm ²)
0	Non-melting, flammable material (untreated cotton, wool, rayon, or silk or blends of these) fabric weight minimum 4.5 oz/yd ² , shirt (long sleeve), pant (long)	N/A
	Protective Equipment – Safety glasses or safety goggles (SR), hearing protection (ear canal inserts), heavy duty leather gloves (AN)	
1	Arc-Rated long sleeve shirt, pants, or coveralls. Arc Rated face shield or Arc Flash suit hood Arc Rated jacket, parka, rainwear, or hard hat liner (AN)	4
	Protective Equipment – Hard hat, safety glasses or safety goggles (SR), hearing protection (ear canal inserts), heavy duty leather gloves (AN), leather work shoes (AN)	
2	Arc-Rated long sleeve shirt, pants or coveralls. Arc Rated face shield and Arc Rated balaclava or Arc Flash suit hood. Arc rated jacket, parka, rainwear, or hard hat liner (AN)	8
	Protective Equipment – Hard hat, safety glasses or safety goggles (SR), hearing protection (ear canal inserts), heavy duty leather gloves (AN), leather work shoes (AN)	
3	Arc-Rated long sleeve shirt, pants and coveralls. Arc Flash hood, Arc Flash suit jacket, arc Rated arc flash suit pants, Arc rated arc flash suit hood, Arc rated gloves, Arc rated jacket, parka, rainwear, or hard hat liner. (AN)	25
	Protective Equipment – Hard hat, safety glasses or safety goggles (SR), hearing protection (ear canal inserts), heavy duty leather gloves (AN), leather work shoes (AN)	
4	Arc-Rated long-sleeve shirt, pants and coveralls. Arc Flash hood, and Arc Flash suit jacket, Arc rated arc flash suite pants, Arc rated arc flash suit hood, Arc rated gloves, Arc rated jacket, parka, rainwear, or hard hat liner.	40
	Protective Equipment – Hard hat, safety glasses or safety goggles (SR), hearing protection (ear canal inserts), heavy duty leather gloves, leather work shoes (AN)	