Avoiding Incidents by Prevention & Protection

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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; the resulting thermal exposure can cause severe burns.

The pressure wave from the blast can reach 200 pounds per square inch. Workers can be knocked down or thrown several feet, resulting in broken bones, brain and internal injuries, and 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.

Understanding arc flash risks requires knowing the data. "Arc flash occurs five to 10 times a day in the U.S.," 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 to $10 million, and in some cases, even higher. There's an average of about one fatality from arc flash per day."

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 recreate the conditions that brought the incident about.

Typically, these investigators are electrical engineers with many years of field experience. They are well-versed in damage from an arc blast, damage from shrapnel and 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.

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 & 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 most recent version — the 2012 edition — became effective in the fall of 2011. 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 below lists the Hazard Risk Categories, the level of protection in small calories of heat energy per square centimeter 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.

Hazard risk categories

Hazard risk category	Protection level	PPE
0	0 to 1.2 cal/cm²	100 % cotton long sleeve shirt
		Long pants
		Safety glasses
		Hearing protection
		Leather and insulated gloves (as required)
		Leather work boots
I	1.2 to 4 cal/cm²	4+ calorie long-sleeve shirt and long pants or coveralls
II	4 to 8 cal/cm²	8+ calorie long-sleeve shirt and long pants or coveralls
III	8 to 25 cal/cm²	25+ calorie arc-flash suit with hood over long-sleeve shirt and long pants
IV	25 to 40 cal/cm²	40+ calorie arc-flash suit with hood over flame-resistant long-sleeve shirt and long pants

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 small calories of heat energy per square centimeter 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 their occurrences. Wearing and using appropriate PPE will reduce your injuries and could save your life.

Photos courtesy of DuPont™

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