Concerned About Arc-Flash and Electric Shock?

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Introduction

Electrocution is the obvious danger faced by anyone working on or near live electrical equipment and it is clearly important to understand shock hazards and wear appropriate protection. However, most electrical accidents are not the result of direct electric shocks. A particularly hazardous type of shorting fault—an arc fault— occurs when the insulation or air separation between high voltage conductors is compromised. Under these conditions, a plasma arc—an “arc flash”—may form between the conductors, unleashing a potentially explosive release of thermal energy.

An arc flash can result in considerable damage to equipment and serious injuries to nearby personnel. A study carried out by the US Department of Labor found that, during a 7-year period, 2,576 US workers died and over 32,000 suffered injuries from electrical shock and burn injuries. 77 % of recorded electrical injuries were due to arc flash incidents. According to statistics compiled by CapSchell Inc (Chicago), every day, in the US alone, there are 5-10 ten arc flash incidents, some fatal. NFPA 70E is the leading internationally recognized safety standard for electrical safety in the workplace. The Canadian Standards Association has developed its own set of standards based on NFPA 70E: CSA Z462.

These standards define a set of safe requirements for personnel working on electrical equipment. To comply with the standards, employers must carry out a hazard risk assessment and ensure that all employees working in a potential arc-

flash hazard zone use appropriate equipment and wear the right protective clothing. Although it is not the responsibility of the thermographer to put in place the appropriate safety procedures, it is important to recognize and understand their need, and to ensure that the correct procedures, equipment and protective clothing are used.

The installation of IR windows, panes or ports allows a thermographer to inspect live electrical equipment without the removal of protective covers and the exposure of equipment. An arc-resistant window, unlike a port or pane, provides additional protection for the thermographer in the event of an arc flash resulting from unexpected component failures or work on other parts of the system. This substantially reduces the hazard rating for the inspections and, in most cases, may allow the thermographer to work more safely minimizing the need for excessively bulky and cumbersome protective clothing.

The consequences of an arc flash

Arc faults are potentially fatal to any personnel in the vicinity. The intense heat of the arc flash can severely burn human skin and ignite the clothing of anyone within several feet of the incident. Treatment for arc flash burns can involve years of skin grafts.

Without proper eye protection, projectiles and molten debris can cause eye damage. The intense UV radiation associated with the flash can cause retinal damage. Superheated vapors can injure lungs and impair breathing. The thermoacoustic blast can damage hearing with ruptured eardrums, cause collapsed lungs and damage other internal organs. The blast can knock personnel off their feet; falls may result in broken bones or lead to electrocution or further injuries on other parts of the system.

Inevitably, a serious arc flash will damage or even destroy the affected equipment. This leads to extensive downtime and expensive replacement and repair.

An incident may also represent a failure on the part of the employer to comply with industry guidelines and regulations. This could result in a fine, litigation fees, increased insurance costs, expensive legal actions and accident investigations.

NFPA 70E—the safety standard

NFPA 70E defines the safe parameters for personnel working on electrical equipment.
Although adherence is not a legal requirement, the standard provides a benchmark for most industries to demonstrate compliance with OSHA’s General Duty clause. An employer adopting the guidelines offered in NFPA 70E demonstrates a clear commitment to safe working practices and the protection of employees from shock and arc flash hazards.

According to the standard, if personnel will be operating in the presence of energized equipment, then certain safety considerations are applicable. 70E

recognizes that there may be the potential for arc flash and arc blast even when conductors are not exposed. Qualified personnel responsible for the work must:
• Conduct an arc flash hazard analysis
• Implement qualified and general worker safety training based on the results
• Establish shock and flash protection boundaries
• Provide protective clothing and personal protective equipment to ANSI standards
• Put warning labels on equipment
• Authorize the job with a ‘live work’ permit

Choosing the right PPE

As an option to incident energy analysis to assist in the choice of appropriate personal protection equipment for arc flash hazards, NFPA 70E defines five hazard risk categories (HRCs): 0, 1, 2, 3, and 4.

Clearly, the potential injurious effects of an arc flash can be reduced by using a fire flame resistant (FR) suit of a suitable calorie rating to reduce the indecent energy on the body to an extent that the burns suffered are not life threatening.

While safety is the paramount concern, it is important to select PPE appropriate for the task. It might seem a good idea to insist on category 4 PPE for all live work, perhaps to avoid a time-consuming arc flash hazard analysis, and this may outwardly appear to be a ‘safe’ policy for personnel. However, the use of restrictive or excessive PPE can also be hazardous: an over-heating worker struggling with poor visibility and restricted movement is more likely to have an accident. More accidents, more downtime. In addition, there are scenarios where HRC may not be enough arc-flash protection. The HRC does not account for arc-blast. NFPA 70E provides several tables listing the PPE appropriate for work within the flash protection boundary: clothing and equipment such as gloves, hats or hoods.

In addition to the HRC classification, PPE is often described by the arc thermal performance value (APTV). This corresponds to the capability of the garment to withstand a particular incident energy (in cal/cm^2).

As we have already discussed, the flash protection boundary defines the distance where an arc flash would produce incident energy of $1.2 cal/cm^2$: a level at which 2nd degree burns could occur. This corresponds to risk category 0. In practice, a worker will need to approach the electrical system much closer than the flash protection boundary. It is therefore important to calculate the likely incident energy for the working position and select PPE accordingly. Most garments are tested and rated for incident radiation at a distance of either 18 inches or 24 inches. This roughly corresponds with the position of the head and chest when working directly on equipment. Of course, during an arc flash incident, the hands and arms may be much closer to the arc fault source and may need protective equipment with a considerably higher rating.

While NFPA 70E and IEEE 1584 cover the PPE requirements for arc flash protection,

there are also other considerations and standards to include in any safety appraisal. Workers may require eye protection, insulating gloves, ear and hearing protection, head impact protection and reinforced footwear.

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