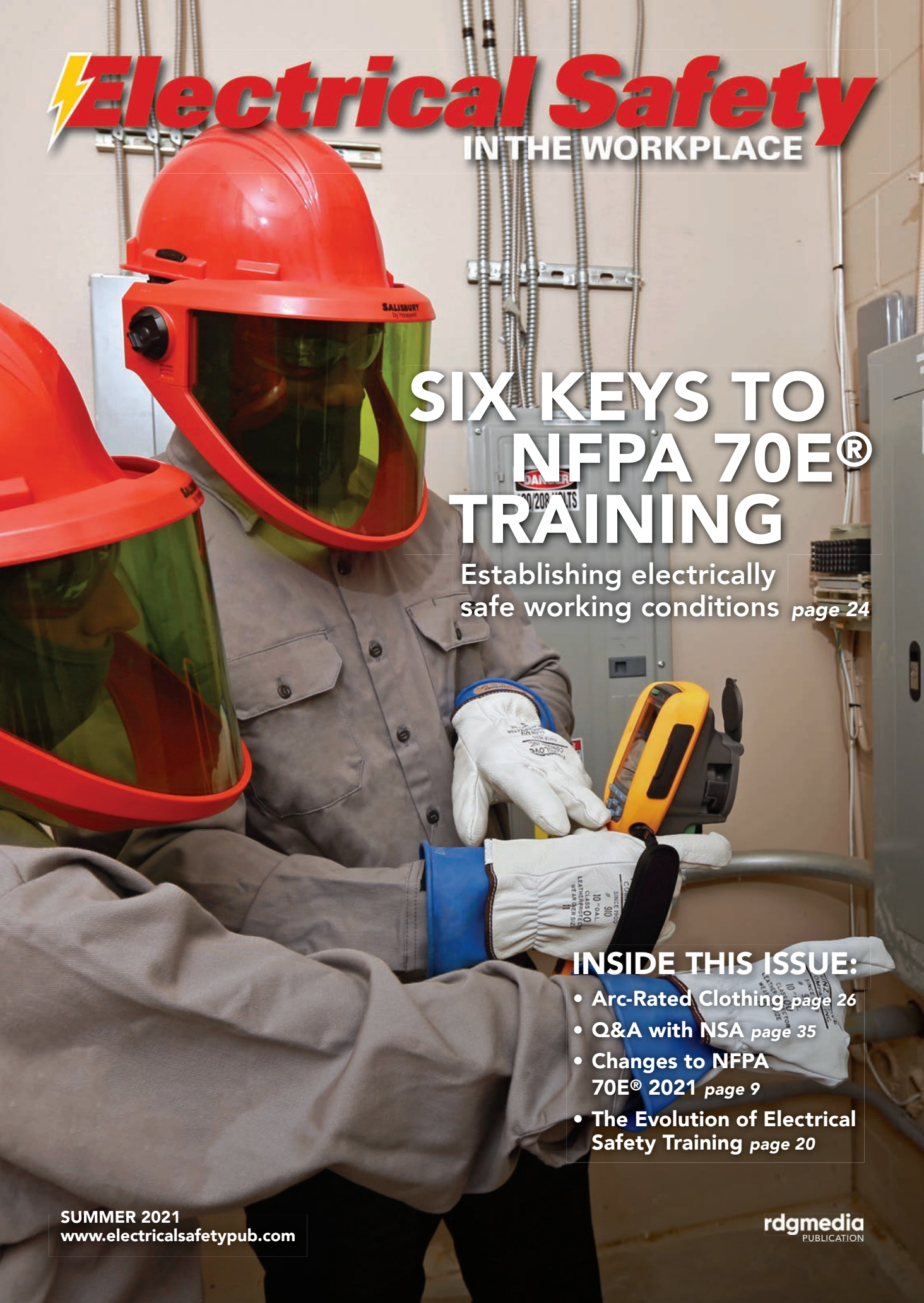

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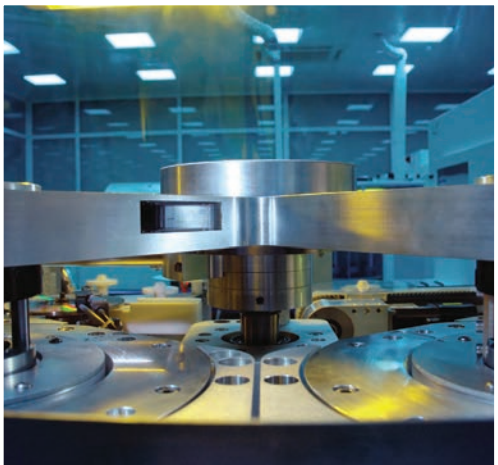

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PUBLISHER'S NOTE

Welcome to our summer issue! As you may have noticed, this publication has really taken a life of its own – focusing on electrical safety and arc flash protection of both people and assets. In this issue, you will read a solid dozen articles from industry professionals sharing insights and best practices on this focus, starting with our cover story, "Six Keys to NFPA 70E® Training". This article will share with you six key takeaways to avoiding electrical injuries, OSHA violations, and even deaths – this is a MUST READ!

Moving on, you will read focused content that was organized in groupings after the cover story. To start out, we are covering two very important standards: Changes to the NFPA 70E® 2021" and "The OSHA Standard for The Control of Hazardous Energy (Lockout/Tagout)". These two articles will give you a better understanding of how to stay compliant and keep your workers safe. Following this, the content is rounded out to include articles on topics like electrical safety, arc flash, PPE, and even training.

Thank you to this issue's advertisers and to those who have supported us since our launch last fall. Watch for our last issue of the year, coming out this fall. Also, if you're interested, let's connect at the Annual NECA 2021 Conference – I will be there looking for some additional 2022 contributors.

If you would like to contribute an article in our last issue of the year (which would be due by mid-August), drop me a note at **randy@rdgmedia.net** or give me a call at **586-227-9344**.

Thanks, and enjoy your summer!

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Electrical Safety IN THE WORKPLACE

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Changes to NFPA 70E® 2021 for Electrical Safety in the Workplace®

IMPORTANT TO KNOW

Electricity has long been recognized as a serious workplace hazard, for both people who work directly with it – such as electricians and engineers – and others who may work with electricity indirectly. Potential sources of exposure are many: overhead lines, cable harnesses, circuit assemblies and more. In a fraction of an instant, an electrical incident can kill, injure, or disable a worker. Electrical injuries to workers can result from electrocution, shock, burns, or from falls caused by the worker coming into contact with electrical energy. In 2018, 160 workers were killed and 1,560 injured in U.S. workplaces, according to the Electrical Safety Foundation International (ESFI).[1] More than half of the fatal electrical injuries that year occurred in the construction industry.

NFPA 70E, which was originally developed at OSHA's request, is considered the definitive standard for electrical safety in the workplace. It includes information about arc flash incident energy, lockout-tagout procedures and personal protective equipment (PPE) that can mitigate the risk of an electrical injury.

1 https://tinyurl.com/y5723f9f

STANDARD REQUIREMENTS

Whenever possible, turn off electrical power during the work being done and verify that it stays off until the task is completed. This can be done by: individual qualified employee control; simple lockout/tagout or complex lockout/tagout.

When it is necessary to work "live" near exposed energized parts, a live work permit that describes the work to be performed and why it must be performed should be signed by the customer, engineers or other person in charge.

For shock protection, three shock hazard boundaries should be determined: limited approach, restricted, and prohibited. These boundaries help identify who should be allowed (i.e., only qualified persons can enter the restricted approach boundary) and when workers must use voltage-rated rubber gloves and fiberglass tools.

The flash protection boundary (FPB) must also be determined. Anyone working closer than 48in to live parts must wear PPE to protect against arc flash. This may include overalls, jackets, and vests made of material that blocks heat energy and that has non-conducive hardware.

DID YOU KNOW?

The National Fire Protection Association (NFPA) uses public input and public comment in the development of its standards, which are then considered at an NFPA Technical Meeting and are subject to appeals or issuance through Standards Council Action. All NFPA standards are revised and updated every three to five years, in revision cycles that begin twice each year.

The NFPA formed a new electrical standards development committee in order to develop an electrical safety standard in 1976, at the request of OSHA. NFPA 70E was first published in 1979. A noteworthy development occurred in 1995, when the arc flash hazard was mentioned in NFPA 70E. This was the first time arc flash was formally addressed in a safety standard. NFPA describes an arc flash hazard as a "source of possible injury or damage to health associated with the release of energy caused by an electric arc." Arc flash had been identified and named as an electrical hazard only 13 years prior to version of NFPA 70E.

The standard is important for electrical engineers, safety managers, electricians, electrical contractors, plant managers, facility maintenance personnel, electrical inspectors, risk managers, mechanical engineers, HVAC installers, designers, and project managers.

NFPA 70E continues to evolve (an update will be released this year), to contain the latest information about the effects of arc flash, arc blast, and direct current (dc) hazards, and recent developments in electrical design and PPE. The standard now emphasizes using the hierarchy of risk controls to eliminate hazards.

Work practices including using boundaries, signs and barricades to designate a "safe work zone" can also help keep workers safe.

The Hazard/Risk Category (HRC) must be determined, based on tables provided by the standard. Determine Hazard/Risk Category (HRC). The HRC level helps electrical workers select the correct type of PPE to wear, based upon the task they are performing live.

Workers must wear appropriate PPE whenever they are performing tasks within the FPB, whether or not they are actually touching the live equipment.

A LOOK AT THE REVISIONS

Some of the 2021 revisions have been reorganizing. For instance, Article 110 of the standard – General Requirements for Electrical Safety-Related Work Practices – has been revised to consolidate general requirements for electrical safety-related work programs, practices and procedures from other articles. The first priority in implementing these work practices is hazard elimination. Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts are to be put into an electrically safe condition before an employee performs work if the individual is within the limited approach boundary and/or the individual interacts with equipment where conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

Electrical safety training for employees exposed to specific hazards associated with electrical energy is to be classroom-based, on-the-job, or a combination of the two. New to the 2021 edition: classroom training can include interactive electronic or interactive web-based training components.

The 2021 70E® edition places a new emphasis on keeping on file, documenting, and following the recommendations of electrical equipment and PPE manufacturers' instructions. Manufacturers' instructions sometimes have been skipped because the information might be hard to access, forcing workers to dig through equipment packaging, or small print instructions have made readability difficult. Manufacturers must now make instructions and recommendations more readable and more accessible.

Personal protective equipment (PPE) constitutes part of NFPA 70E®. PPE includes nonconductive head protection, eye protection, hearing protection, and arc-rated clothing whenever there is possible exposure to an electric arc flash, insulating blankets, and non-melting footwear. The 2021 edition addresses the common practice of wearing high-visibility vests over arc rated clothing. In the past qualified workers that were required to wear high-visibility vests had to remove the vests if the vest did not meet the level of arc flash protection required. Now qualified workers can wear a category 1 arc rated high-visibility vests (4 cal/cm2) during the workday and not have to remove it to perform electrical troubleshooting or voltage measurements.

Acceptable electrical safety footwear has been expanded in the 2021 edition to go beyond traditional leather footwear to include other types footwear other than leather or dielectric as long as it has been tested to demonstrate no ignition, melting, or dripping at the estimated incident energy exposure or the minimum arc rating for the respective arc flash PPE category.

In addition, the definition of balaclava has been changed. The word "hood" and "sock" were removed. The new definition: an arc-rated head-protective fabric that protects the neck and head except for a small portion of the facial area.

INCREASE YOUR KNOWLEDGE

The complete standard is available online at: https://webstore.ansi.org. ESW

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The OSHA Standard for The Control of Hazardous Energy (Lockout/Tagout)

IMPORTANT TO KNOW

If your employees service or maintain machines, where the unexpected startup, energization, or the release of stored energy could cause injury, then OSHA's Control of Hazardous Energy (Lockout/Tagout) Standards should be at the forefront of your safety protocols and procedures.

According to OSHA, employees servicing or maintaining machines or equipment may be exposed to serious physical harm or death if hazardous energy is not properly controlled. Craft workers, machine operators, and laborers are among the 3 million workers who service equipment and face the greatest risk. Compliance with the lockout/tagout (LOTO) standard prevents an estimated 120 fatalities and 50,000 injuries each year.

The LOTO standard establishes the employer's responsibility to protect employees from hazardous energy sources on machines and equipment during service and maintenance. The standard gives each employer the flexibility to develop an energy control program suited to the needs of the particular workplace and the types of machines and equipment being maintained or serviced. This is generally done by affixing the appropriate lockout or tagout devices to energy-isolating devices and by deenergizing machines and equipment. Remember, employees need to be trained to ensure that they know, understand, and follow the applicable provisions of the hazardous energy control procedures.

The standards establish requirements that employers must follow and outlined below are the most critical:

- Develop, implement, and enforce an energy control program.
- Use lockout devices for equipment that can be locked out. Tagout devices may be used in lieu of lockout devices only if the tagout program provides employee protection equivalent to that provided through a lockout program.
- Ensure that new or overhauled equipment is capable of being locked out.
- Develop, document, implement, and enforce energy control procedures. [See the note to 29 CFR 1910.147(c)(4)(i) for an exception to the documentation requirements.]
- Use only lockout/tagout devices authorized for the particular equipment or machinery and ensure that they are durable, standardized, and substantial.
- Establish a policy that permits only the employee who applied a lockout/tagout device to remove it. [See 29 CFR 1910.147(e)(3) for exception.]
- Inspect energy control procedures at least annually.
- Provide effective training as mandated for all employees covered by the standard.
- Comply with the additional energy control provisions in OSHA standards when machines or equipment must be tested or repositioned, when outside contractors work at the site, in group lockout situations, and during shift or personnel changes.

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Visit OSHA's eTool for an interactive training program that will expand your knowledge of the LOTO standard. Additionally, OSHA has various publications, standards, technical assistance, and compliance tools to help you. These are available at www.osha.gov. ESW

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Electrical Shock: Downplayed and Deadly

Why relying on safety training and PPE can be fatal.

By Rachel Metea, Contributor

When workers are unsafe, a company cannot prosper. Unfortunately, electrical shock incidents are not only dangerous, but common. Until companies shift their focus to preventing hazards instead of preventing incidents within hazardous conditions, lives, company morale, productivity, and OSHA fines will continue to be on the line.

More than 90% of electrical fatalities among U.S. workers are due to electrical shock. This does not account for the high proportion of injuries and fatalities that are often misclassified under a different cause of death. And yet shock is downplayed within industrial settings. Most electrical safety training programs do not cover shock. Even with training, workers during production usually do not exercise precaution against it.

Oftentimes, companies' safety methods primarily focus on providing workers with PPE and safety training, which they assume makes them safe from any incidents occurring. However, PPE is considered the last line of defense on the hierarchy of controls, with safety training (which is an "administrative control") falling next in line. A last line of defense is a last resort, and thus for companies to devote their resources to using last-resort protection methods, the disproportionate rate of worker fatalities due to electrical shock each year comes as no surprise. To ensure your workers are safe, place emphasis on the only bottom line that matters: prevention through design saves lives.

WHAT THE LITTELFUSE SURVEY FOUND

The Respondents: Littelfuse surveyed 575 people who work directly with electricity from Jan. 23 to Feb. 21, 2020. Roughly 70% of the people surveyed primarily work with more than 220 volts, and the other 30% mostly work with 220 volts or less. Company size was evenly represented among the respondents (29% work at companies with more than 1,000 employees, 21% work at companies with 1 to 19 employees).

Nearly 40% of the respondents said they have been shocked by more than 220 volts while on the job, which was about half (51%) of the 78% who reported having been electrically shocked by any voltage (see Figure 1).

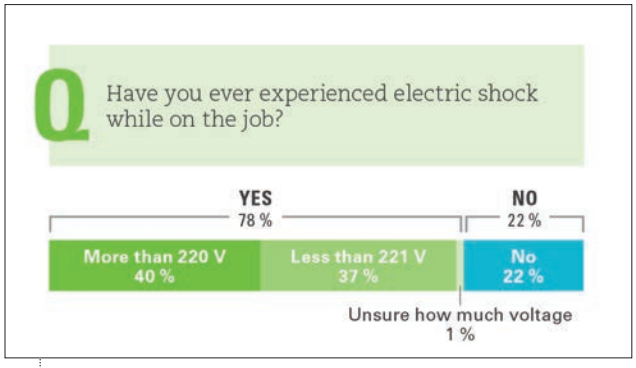

Figure 1. Most respondents have been electrically shocked while on the job, half of which by more than 220 volts.

Most (86%) of the respondents who reported having experienced more than a 220-V shock also rated themselves as either "very confident" or "extremely confident" when they were asked to rate their ability to recognize an electrical hazard. This was significantly more than those who have never been shocked when on the job and slightly higher than those who reported having experienced shock from less than 220 volts (82%) (see Figure 2). Overconfidence was also frequently cited among respondents as the main reason why people at their facility work on live equipment.

Also, more than two-thirds of the respondents said that workers in their facility perform work on energized equipment. This is not only incredibly dangerous but is illegal per OSHA's 29 CFR 1910.333(a)(1), which requires live parts that operate at 50 volts or more to be deenergized before employees work on or near them.

Respondents were asked using an open-answer field to cite the main reason people at their facility work on energized equipment: troubleshooting was the most common justification, followed by respondents provided for working on energized equipment. The second most common rationale was for production purposes (such as to avoid the economic loss of stopping the equipment), followed by overconfidence.

LET-DOWNS IN SAFETY TRAINING

When analyzing the results, it became clear that not every facility's safety training is working. For example, every respondent who cited PPE (or a form of it, such as gloves) as the main reason for why workers at their facility work on equipment while it's energized also said they are provided electrical safety training by their workplace. If a worker believes they do not need to de-energize equipment if they wear PPE, then their safety training has failed.

Most alarmingly, among the respondents who cited PPE gloves and boots as the main reason for not de-energizing equipment before working on it also said they consider 550 volts or less to be a safe equipment voltage to ground to work on or near.

More than 50 volts of equipment voltage to ground is not safe to work on or near. However, when the survey asked the respondents how much equipment voltage they consider to be safe to work on or near, a quarter of the respondents believed more than 50 V is safe: 77% answered correctly; 9% believed up to 120 volts is safe; 5% considered up to 240 volts as safe; and 9% said 500 V is safe.

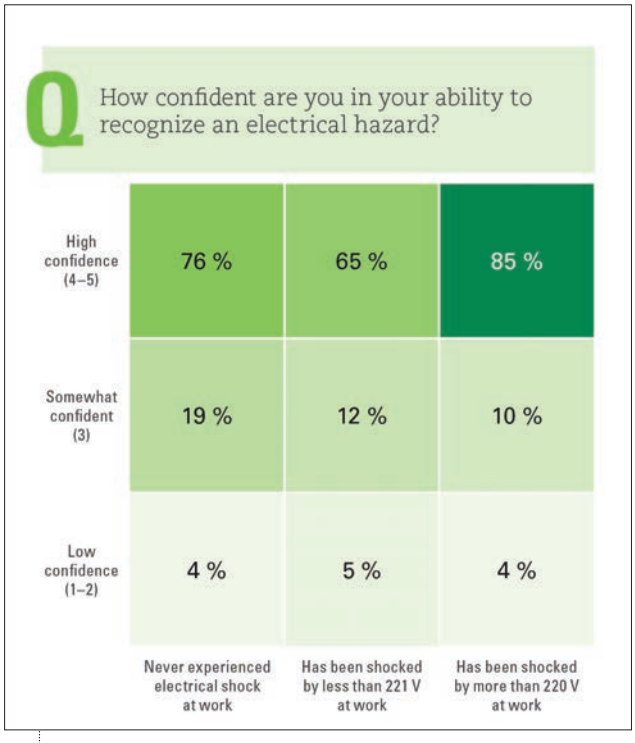

Figure 2. Respondents' experience of electrical shock and self-confidence in ability to recognize an electrical hazard.

The survey found no connection between an accurate knowledge of how much voltage is safe to work on or near (50 volts) and those whose company provides them with safety training (see Figure 3). In other words, the rate of safety-trained workers who considered more than 50 volts to be hazardous to work on or near was the same as the rate of safety trained workers who believed up to 500 volts to be a safe working voltage.

If a worker cannot identify a safe working voltage from a hazardous condition, then their safety training failed. Any pertinent safety practices the worker was able to retain are useless if they can't identify a hazard to begin with.

A corporate case study found that 40% of electrical injury incidents involved 250 volts or less and were indicative of a misconception that electrical safety is a nonissue in low voltages.

If safety training does not help to decrease the misconception that more than 50 volts is dangerous to work around, and if 40% of incidents involving 250 volts or less are due to this misconception, then safety by design is essential, even where not required under NEC.

Companies usually emphasize safety in hypothetical situations, but not when the situation occurs in real-time. Even the principles taught in safety training that resonate with workers are often abandoned during business operations.

Electrical injuries and fatalities are one of the most preventable types of occupational injury and fatality, and yet they continue to happen. Unlike other occupational hazards that center around the worker's behavior, electrical shock hazards can be eliminated using a hard-science method: ground-fault circuit interrupters (GFCIs), which do not rely on the soft-based science of human-based behavior for them to work as hoped.

HAPHAZARD PPE PRACTICES

Most industrial sites require employees to wear PPE. However, standard-issue PPE does not protect from electrical shock and electrical workers can be lax in properly wearing electrical PPE. Workers

Figure 3. Safety-trained workers were just as common among those who considered less than 50 volts safe and those who considered less than 500 safe to work on or near.

often complain electrical gloves make it difficult to get the job done because they are cumbersome or bulky. As a result, many workers are found to remove their electrical gloves to perform the work.

While electrical gloves are important, PPE is the last line of defense. Electrical gloves must maintain their dielectric properties, physical strength, flexibility, and durability for them to remain effective. Whether the worker ultimately wears them is a different story.

Safety is already at odds against shock hazards when PPE and training are the only hazard mitigations used by a company. To issue human-error prone workers PPE is important, but PPE that is simply assumed to be in working condition without it undergoing required testing is reckless. PPE is important, but it is not good enough.

Then there are rubber mats, which do not remove the potential for injury and fatality incidents to occur. Workers do not always use the mats due to the hassle of extra work they create when breakers or contactors are racked in or out. Rubber mats are also rendered ineffective when wet, which also causes workers to not use the mats. In wet applications, a three-phase GFCI (which can be used with a cart for portability), is the optimal solution to protect against shock.

WHY GFCIS MATTER

It is easy to defend that any of the bottom hierarchy safety measures are the least effective methods of preventing injury and death. Yet people still rely on these methods as their first resort—which are supposed to be a last-resort method. PPE is required, ground-fault protection is not required for less than 1200 A and shock protection usually isn't. This is not a reflection of their importance and most certainly their ability to protect, but rather it is a reflection of the American legislative process.

GFCIs are specifically designed to protect people from electrical shock. GFCIs monitor the current between a circuit's grounded and ungrounded conductors. Any imbalance (with the exception of small amounts of leakage) indicates that the current is returning through an unintended path (such as through the ground or a person). If the GFCI detects an imbalance, it will rapidly shut off the power.

Class A GFCIs—such as those used in residential applications—shut the power off when the difference between the leaving

and returning currents is 6 mA or more. This trip level, however, is unrealistic for manufacturing applications.

Therefore, plastic manufacturers require special-purpose GFCIs (SPGFCIs), which have a 20-mA trip level at a minimum of 1 second. This provides them with greater flexibility, while still providing complete protection from electrical shock. Additionally, there is a low probability of injury from currents up to 50 mA that last up to 2s with a GFCI, which is in the AC-3 zone (see Figure 4).

Systems that have higher maintenance requirements are less forgiving of human error and more prone to failure. As a reminder, it is the current, not the voltage that kills. This is why Class C, D, and E GFCIs are so important: they monitor the ground-return path continuity and then interrupt power if any integrity is lost. This in turn eliminates the possibility of any personnel being shocked or electrocuted.

Human life is priceless. A reliance on GFCIs (or any elimination method) saves both costs and lives. The cost of an incident exceeds beyond the steepest of OSHA fines. When a company focuses its costs solely on compliance, it fails to consider the cost of an incident. Even the best safety training and PPE for workers will still leave the company vulnerable to electrical shock injury and fatality incidents. Estimated costs should be framed in a way to consider the loss of an incident's destruction by way of property and equipment, downtime, and above all—life.

Only in the aftermath of tragedies is it easy to understand just how important investing in prevention is. Human-based safety methods require them to be executed with consistent precision: without error, by every person, and every time. This is not possible because people make mistakes; it's only human.

The survey results suggest that safety training is not working. If it were, workers would have a more accurate understanding of what makes an electrically hazardous situation, and shock injuries and fatalities would—at the very least—have leveled off over the past several years. Remember this, only a GFCI can protect a person from direct contact with an energized conductor. ESW

Rachel Metea is the technical writer at Littelfuse. She holds a BA in communications and an MA in journalism from DePaul University. Metea is a member of IEEE. A full report of the survey's findings is available at Littelfuse.com/shock-survey. To learn more about GFCIs for manufacturing facilities, visit Littelfuse.com/ShockProtection.

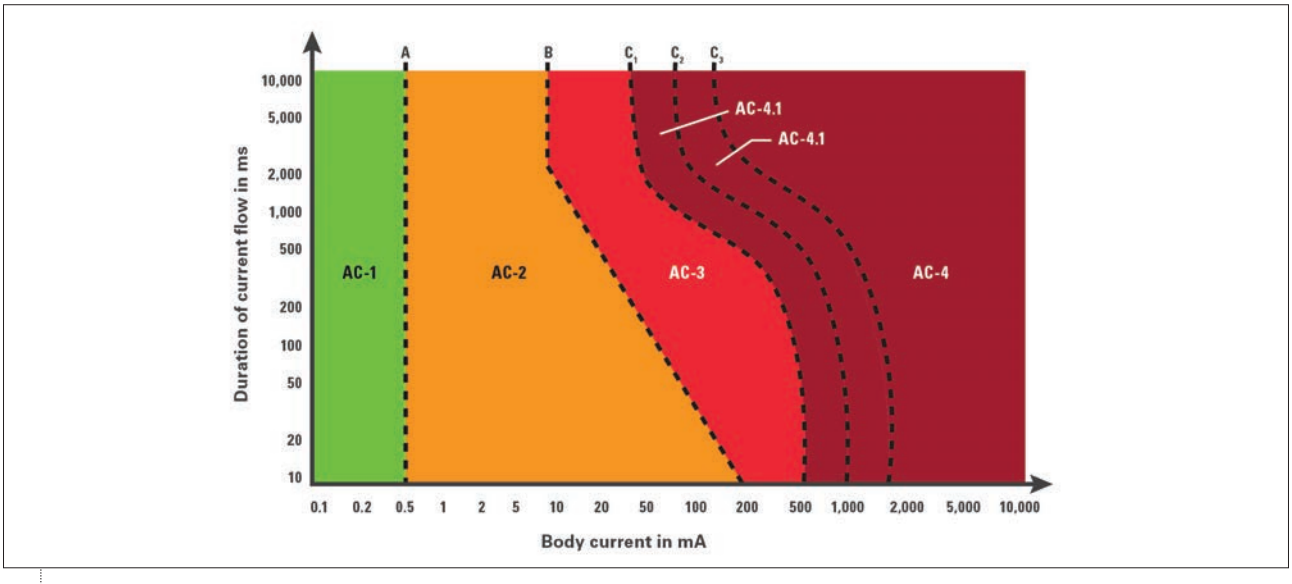

Figure 4. The effects of different levels of the arc flowing through the body, as defined by IEC 60479-1.

The Evolution of Electrical Safety Training in a Time of Social Distancing

By Derek Vigstol, Contributor

During a presentation I gave last year at the IEEE Electrical Safety Workshop, an attendee asked me what I thought the biggest obstacle was facing electrical safety training. At the time, I believed one of the largest roadblocks to training workers exposed to electrical hazards was a long-standing industry culture and mindset that training is just a hoop we have to jump through. One week later, the world found itself in the middle of a global health crisis. Many of us, deemed non-essential workers, saw our businesses and jobs shift to a work-from-home option or shut down completely to slow the spread of COVID-19. However, other jobs such as maintenance personnel and those in skilled trades were deemed essential and had a mountain of work on their plates. For many of those deemed "essential" this meant being exposed to both a health crisis and the everyday hazards that accompany their jobs, such as shock and arc flash.

To further compound the danger, many of the tasks essential employees perform were labeled urgent or of an emergency nature which led to time pressure and stress on the worker; both major error precursors in considering human performance during risk assessments. This combination of already hazardous work and urgent deadlines meant for those doing this work the need to be thoroughly trained in identifying the hazard and the appropriate measures to reduce the risk was greater than ever. There was just one problem; how in the world could we deliver the required electrical safety training for this kind of work in a far-from-normal environment?

ONLINE OPTIONS

One option was for workers to take self-paced online programs on electrical safety topics, like NFPA 70E, Standard for Electrical Safety in the Workplace. Many programs that fit this description have existed for years. However, this type of training has received a fair bit of criticism due to OSHA's many letters of interpretation on self-paced online learning. For those not familiar with what OSHA requires, here is a quick summary: OSHA requires that if training is required, the employer provide that training to each affected employee; OSHA requires that any employee who is exposed to a risk of electric shock be trained in electrically safe work practices (and they have also provided a handy little table of job roles that fit the bill in 1910 subpart S).

It is safe to say that electricians, HVAC technicians, maintenance personnel, and the like are all required to be trained in electrical safety. When personal computers started becoming more popular in the mid-90's, many started to wonder if training could take place on these devices. Questions about online training soon made it to OSHA and warranted a response from the director of the office of health enforcement. While the intent of the question did not specifically pertain to electrical safety, the answer clearly did. OSHA stated that self-paced computer-based training could be a valuable part of an overall training program, but by itself would not satisfy the training requirement. Fast forward to 2019 and the same response was given to a similar question. However, the 2019 response went a bit further: it stated that the student needs to interact with an instructor and gain hands-on experience to really master the skills being taught.

What OSHA intended for the requirement was for employees to learn from someone with more experience and knowledge until they have mastered the skill themselves. Pretty straight forward, right? After all, this learning model has been the cornerstone of the skilled trades for years. But what about during a pandemic? How can a worker get on-the-job experience in this time of social distancing and limited interaction between employees and instructors? Relying on long-established learning models to deliver electrical safety training would not work in this new reality. While certain exceptions were being made in other areas because of the pandemic, thankfully occupational safety was not one of them. Employers could not simply roll the dice and hope it all worked out for the best. So where could employers turn to find electrical safety training for their employees when in-person training was gone and online was not enough by itself?

"The electrical industry has evolved from a few light bulbs and industrial motors in a few select buildings to a world where we can install light fixtures and overcurrent devices that can talk to each other and control other systems within the building automation network."

NEW TRAINING METHODS

Even before the coronavirus pandemic hit the world, NFPA was working on new and innovative ways to provide training to workers. When the lockdown began in early 2020, we set out to deliver the same impactful learning experience that participants received by attending our in-person seminars but in a virtual format. However, this was not as simple as turning on a Zoom meeting and teaching a class. There was a bit of work to do to figure out how to convert our existing two-day 70E seminar into a virtual experience. Things like applications activities, open-ended Q&A sessions with the instructor, and sharing of personal experiences are all teaching tools that work much better in a physical classroom. To help translate this to a virtual classroom, we needed engagement tools that could fit into a seminar format and encourage attendees to voice their opinions and thoughts. Timing was also an issue. A training that is too short would take too many sessions to cover the needed information but too long of a training and attendees might start to get distracted and answer emails or perform other tasks during the session. Either of these would not create that learning experience that OSHA states

is necessary for the worker to master the skill of electrical safety. Still another angle we considered was offering smaller focused training sessions. NFPA developed two such options; one on the changes to NFPA 70E from the 2018 to 2021 editions; the other on how a worker can effectively apply the PPE Category method from NFPA 70E for selection of arc flash protective equipment. The latter seeks to teach the selection of arc flash PPE as a skill instead by guiding the learner through the process.

Even with the many adaptations that have come out of this challenging new environment, we are still missing the practice element. To date, there is yet to be a substitute for good old fashioned hands-on experience. However, there have been a number of advancements in the safety training realm that might prove crucial in this social distancing age we now live in. Virtual reality (VR) helps workers practice certain tasks and skills without actually being exposed to a real hazard. Augmented reality (AR) takes things a step further and allows a knowledgeable instructor to be riding shotgun with the person learning so that he/she can immediately get the information they need about the task or equipment with which they are about to engage. While both these methods are still facing an uphill climb before they reach mainstream status, I think it is safe to say that the cat is out of the bag on the value these technologies can bring to an employer's training program. It is just a matter of time before VR and AR are a full-blown part of every worker's day to day.

There is no question that the pandemic has taken many of us by storm and has redefined much of our business as usual, but we don't have to let this minor setback change who we are. Remember, the electrical industry has evolved from a few light bulbs and industrial motors in a few select buildings to a world where we can install light fixtures and overcurrent devices that can talk to each other and control other systems within the building automation network. We are an industry of the best and the brightest, of problem solvers and pioneers. I have faith that the lessons learned through adversity during the last year will lead to giant leaps in protecting workers from the hazards that working with electricity leads to. However, it's going to take an all-hands-on-deck approach. This is not a problem for a single person or organization to tackle. Like NFPA's slogan says, "It's a big world, let's protect it together!" We have come a long way in the last few years with respect to electrical safety, so let's go the distance and make a pledge to work together to achieve zero deaths in the workplace. ESW

Derek Vigstol is the Electrical Content Specialist for NFPA. Digital access to NFPA codes and standards, along with related information and insights like expert commentary, visual aids, and other relevant resources is available to help you work more efficiently, effectively, and safely at work (https://nfpa.org/link).

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Six Keys to NFPA 70E® Training

By Jay Smith, Contributor

NFPA 70E® training teaches you how the standard's life-saving work practices help avoid electrical injuries, deaths, and OSHA violations. Training covers many topics, including establishing electrically safe work conditions, elements of a risk assessment, the difference between electrical hazards and risks, and the intent and limitations of personal protective equipment (PPE) required by 70E. Here are six key training considerations to address:

1. The changing workforce

A number of facility maintenance crews are bleeding knowledge—about facilities, hazards, electrical equipment—as the workforce ages with waves of retirements. This heightens the importance of NFPA 70E training for younger generations of workers who have not witnessed the evolution of electrical safety and arc flash safety in particular. Only in the past 15 years or so, since 2005-2006, when OSHA started citing companies for arc flash accidents, has arc flash knowledge and protections gained traction.

Older workers have seen an arc flash, been shocked, escaped near misses. They have decades of on-the-job knowledge, including identifying hazards and making hazard assessments.

Electrical safety training for newer workers should be led by instructors who can relate personal stories, accidents and close calls, case studies to bring 70E requirements to life. That dose of reality won't come from viewing slide in a PowerPoint or a video. It helps to be trained by someone who have been there, done that, and likely scarred along the way.

2. Arc flash causes

A key point in 70E training is explaining how an arc flash occurs, and its causes. There are usually two main contributing factors. Either equipment has failed, or there is a physical interaction with an energized piece of equipment, such as removing a panel and working with a circuit breaker. Other causes include human error, failing to use insulated tools, excessive dust, corrosion, improperly maintained or installed switches and circuit breakers, use of substandard parts, and condensation near electrical equipment. Arc flash temperatures can reach as high as 35,000°F, hotter than the surface of the sun.

3. Equipment with arc flash potential
Another key learning in 70E training cover the types of equipment with arc flash potential. Safety issues are raised whenever personnel work with an overcurrent protective device, such as circuit breakers or fuses. These devices protect against the potentially dangerous effects of overcurrents, such as an overload current or a short-circuit current, which creates a fault current. In general, an arc flash assessment or arc flash hazard study / analysis should be performed on equipment at 50 V or higher. The IEEE 1584 standard is also used for guidance on the types of equipment with arc flash potential. Opinions vary on the equipment capable of producing an arc flash, but safe to say we're not talking about a light switch or an electrical outlet.

4. Protection before an arc flash assessment has been performed
What should be done if an arc flash assessment hasn't been performed? An arc flash risk assessment is a process to determine the level of hazard that exists at each electrical enclosure, such as a control panel, panelboard, disconnect switch or switchgear. Outside providers like SEAM Group can perform Arc Flash Risk Assessments to identify and document potential arc flash hazards for all facilities with three-phase electrical power systems, which is required by NFPA 70E. This standard covers every type of commercial, industrial and institutional facility. 70E training offers guidance on recommended levels of personal protective equipment (PPE) matched to equipment types, voltages, and tasks to be performed. For example, PPE should be worn at all times when working in the facility, and 40 cal suits should be work for higher potential exposures. A bit of guesswork is involved until the arc flash assessment has been conducted.

5. Understanding arc flash labeling
Assessment findings lead to applying arc flash labels on equipment and learning how to read data on the labels is another key point in 70E training. Labeling is required for any piece of electrical equipment that may need examination, adjustment, service or maintenance while energized, creating the potential for an arc flash incident to occur. At a minimum, NFPA 70E labels must contain the nominal system voltage, the arc flash boundary, and one of the following: the available incident energy and the corresponding working distance or the arc flash PPE category found in the NFPA 70E PPE category tables, the minimum arc rating of clothing, or the site-specific level of PPE. Electrical workers need to understand approach boundaries for both arc and shock hazards, how it affects the work of the person performing the diagnostics, as well as the risk to nearby coworkers, not only on the same level, but working above or below the task at hand.

6. Meter use documented training
One more point relating to 70E training: the standard requires qualified employees to have documented training on how to use a meter and how to interpret all indications coming from the metering device. This documentation is often overlooked in a qualified person program. Your qualified workers must be hands-on trained on using a meter and reading interpretations. Meter readings can vary greatly depending on where the meter is placed, such as if you're testing a 480 system, a phase to phase or phase to ground procedure.

These six points are often overlooked when deciphering NFPA 70E® requirements and setting the parameters for your training. The changing workforce and new adult learning styles must be taken in account. Arc flash is a lethal hazard and understanding arc flash causes should be at the forefront of training. Not often covered, though it should be, are the types of equipment that can produce an arc flash. Also often not cover in training is what to do for protection before an arc flash hazard assessment is performed. Arc flash labeling can be filled with details, small print, and deserves special attention in training because understanding labels can be a life saver. Finally, all your training should be documented. Document everything, including meter use by a qualified person. ESW

Jay Smith is the Director - Electrical Safety Services, SEAM Group (www.seamgroup.com).

Don't Think Your Company Needs Arc-Rated Clothing? Four Big Reasons That's Probably Wrong

By Scott Margolin, Co-Chairman, The Partnership for Electrical Safety

If you've ever asked the question, or even just wondered "Does my company need arc-rated clothing?" chances are very high the answer is yes, even if the answer you got at the time was no. That's because many people misunderstand one or more of four major factors: the hazard, the standard, OSHA's position, or mitigation strategies. If you have any facilities which use electricity at 50 volts or greater, or work on them (and aren't an electric utility) NFPA 70E applies to you. That's pretty much everyone in the U.S.

THE HAZARD

Arc flashes can occur in essentially any energized equipment, including low voltage; the number one for injuries and fatalities is "only" 480V. There's no such thing as a small arc flash when you're the person in its path…3 cals is smaller than 6 cals, but they all produce extraordinary temperatures (30,000°F, four times hotter than the surface of the sun) and significant quantities of molten metal. Molten copper is >1900°F and can burn exposed skin and ignite flammable clothing. The vast majority of catastrophic injuries and fatalities are caused by the arc igniting flammable clothing, not by the arc itself. The remedy for this is simple – don't work energized if you don't have to, and don't wear fuel. All non-AR/FR clothing, including 100% cotton, is fuel. Too many people have emerged from hazard analysis specifying 100% cotton; this is worse, both with regard to safety and legally, than doing nothing. Cotton is NOT PPE – it ignites easily, burns hotter, spreads quickly, and is harder to extinguish. When someone specifies cotton, they are acknowledging a thermal hazard (by banning meltable fibers), but cotton is not protective, and is not compliant with OSHA or NFPA 70E as the outer layer.

You may be able to engineer the hazard down in frequency and down in incident energy, but it cannot be eliminated during energized work. Despite the best training, gear, and behavioral safety in the world, arc flashes continue to occur frequently. The only remedy given this fact set is arc-rated clothing and associated PPE. That's why OSHA and 70E both require it.

Despite the best training, gear, and behavioral safety in the world, arc flashes continue to occur frequently.

THE STANDARD

NFPA 70E addressed arc flash over twenty years ago, in 2000; the standard makes it clear that anyone working on or near energized electrical gear at 50V or above must be provided with AR clothing and other PPE. 70E provides excellent hazard analysis tools, incident energy estimation tables, and risk mitigation procedures. One of

those tools helps determine if an arc flash hazard exists; if the answer is yes (hint: it's almost always yes), all the appropriate PPE must be worn. 70E encourages de-energization whenever possible and allows for hot work only when de-energizing is infeasible.

During the first several years after arc flash was added to 70E, many companies brought their electrical programs into compliance, protecting over a million workers in the process. However, in the U.S. today about 500,000 industrial electrical workers still are not being provided AR clothing, despite a clear standard and OSHA statements, enforcement, and fines. The standard has dramatically reduced serious injuries and fatalities among the protected population, but unprotected workers continue to suffer unnecessarily.

OSHA'S POSITION

OSHA prohibits any clothing which could increase the extent or severity of injury in an arc flash; this prohibits any and all flammable clothing, including 100% cotton. They also classify AR clothing as PPE, meaning the employer is required to provide the garments, and they require that the AR garments have an arc rating greater than the predicted incident energy exposure.

OSHA's relationship with 70E is relatively simple: OSHA tells us what we SHALL do, but not how to do it. NFPA standards (including 70E) tell us how to accomplish what OSHA requires – they gather experts in the relevant industries and create standards that instruct the industry how to protect their workers and comply with OSHA. In other words, OSHA tells us we shall provide a workplace free of recognized hazards, and where we cannot engineer the hazard out, we shall provide appropriate PPE. NFPA 70E picks up where OSHA leaves off and tells us how to conduct hazard analysis and how to protect workers. Thus, OSHA and NFPA 70E work in tandem, and have since the beginning. OSHA encouraged the NFPA 70E committee to include the arc flash hazard in the late 90s; OSHA's top electrical expert was on the 70E committee during the writing and many revision cycles since; and OSHA cites 70E regularly. OSHA has also made it quite clear that one cannot sell liability; that is, the host employer is responsible for providing incident energy information to any contractors they may employ.

MITIGATION STRATEGIES

There are several common pitfalls here: Some companies claim they do not work energized. However, there are energized work steps in every de-energization process: de-energize, confirm absence of voltage, re-energize, and confirm presence of voltage. PPE is still required. The only truly "never energized" work is pulling wire in a building not yet connected to the grid or a generator.

Some companies claim incident energies are too low to require PPE. This is wrong on many levels. Those calculations generally assume the worker is 18 in and that the breaker will clear as designed. However, people are often closer, and breakers often stick (require more cycles than when new). Both of these variables will cause significant increases in incident energy. Molten metal, as noted earlier, is a significant ignition hazard and is created by virtually all arcs.

Some companies continue to believe the myth that cotton is protective or compliant. It is neither.

Some companies provide a few kit bags of 25 or 40 cal suits, to be shared among dozens or hundreds of workers who are wearing flammable clothing such as 100% cotton, and then claim compliance has been achieved. This may be true in theory, but it is almost never true in reality. Kits get left at the office, in the truck, or are borrowed by someone at another job site. Workers refuse to wear shared gear due to hygiene issues, won't take the time to find and don them, or take them off too soon. The majority of serious injuries among workers who have been issued AR clothing occur in these types of task-based programs, because the injured worker was not wearing the PPE.

Some companies simply refuse to provide AR clothing based on long-outdated ideas around comfort, cost or heat stress. But today's AR pants and shirts look, feel, weigh, wash, and wear just like regular street clothing, including many of the same brands and styles, and most cost only a little more. And note that no single layer, breathable apparel is a contributor to heat stress, whether it is FR, AR, or flammable, short sleeve or long sleeve, light or normal weight; Heat stress is caused by poor hydration, lack of shade, lack of rest breaks, and some illnesses or medications. Clothing helps cause heat stress when it is non-breathable (rainwear, Tyvek, etc.) or multiple layer (40 cal suits, etc.) …not when it's breathable single layer AR or FR clothing.

Does your company need arc-rated clothing? OSHA and NFPA 70E agree - If you work on or near energized electrical gear above 50 volts, the answer is almost certainly yes. Arc flash doesn't occur as often as slips/trips/falls, but the results without PPE when it does are almost always catastrophic. Unlike many hazards, the remedy is amazingly simple: don't work energized and don't wear fuel. ESW

Electrical Worker Safety: Supplying Headlamps as Critical PPE in Hazardous Environments

By Dave Cozzone, Contributor

Plants and facilities have a duty to protect employees by providing a safe work environment and Personal Protective Equipment (PPE) required for the job. However, despite various PPE options, many companies fail to supply or specify important lighting tools – namely headlamps. Unfortunately, the lack of suitable headlamps can lead to serious, even deadly accidents, in hazardous locations.

As a tool, headlamps are essential when hands-free lighting is required in low-light areas for a wide range of tasks, such as operating and maintaining electrical equipment or assessing its condition. Headlamps are also necessary for safe, efficient personnel movement throughout the plant, particularly in confined or restricted spaces. At sites with flammable gases, vapors, liquids, materials, or dusts on the premises or in the air and when working on electrical equipment, having a headlamp that does not generate a spark is critical.

However, despite meeting OSHA's definition of PPE, "equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses," headlamps are often not included in corporate budgets for PPE. As a result, workers may be left to purchase their own headlamps from industry supply or hardware stores. Unfortunately, if they overemphasize price and choose products that lack necessary options, the units may be unsafe to use for some tasks, settings, or conditions throughout the plant. This could open the company to potential liability.

To protect personnel in any work environment and to defend against such liability, a growing number of safety officers are including or specifying headlamps in the company budget, as PPE.

"It is safer for facilities to provide suitable headlamps upfront rather than leaving it up to employees to make their own purchases. However, department approval of only intrinsically safe product would handle the issue. Preventing even one serious injury, fire, or explosion would pay for any implementation," said Scott Colarusso, General Manager and Co-Owner, of a supplier of fire safety equipment that has equipped and trained thousands of firefighters nationwide.

To protect personnel in any work environment, a growing number of industrial safety officers are including headlamps in the company budget, as PPE.

When companies supply intrinsically safe headlamps, which are specifically designed not to be a source of ignition in hazardous zones, this protects workers wherever they need to go in the plant from serious, even potentially lethal accidents. Essentially, everyone is covered, and the chance of mishap eliminated.

"Without safety certified headlamps appropriate for the application, facilities are exposed to potential liability if an incident occurs. By supplying workers with headlamps that are rated for any hazardous environment [that could be encountered in the plant], companies can prevent the problem," said Colarusso.

MANDATING GREATER SAFETY

At worksites, headlamps enhance personnel safety and efficiency since wherever they look the lighting goes with them, leaving their hands free. With multiple beam modes, these devices are designed to be easily operable even when workers wear heavy gloves. Typically, the units are waterproof and chemically resistant, ready for use in rugged surroundings, which may include getting thrown into a truck toolbox or dropped. Still, the devices must provide ample light for a

sufficient "burn time" to last an entire work shift without a change of batteries.

Across a range of industries, however, typical headlamps can be a dangerous source of ignition if workers unwittingly enter a hazardous area or are exposed to flammable materials or conditions.

Safety considerations are particularly important considering OSHA's recently issued standard for work in confined spaces (Subpart AA of 29 CFR 1926). The new standard recognizes that such spaces can present physical and atmospheric hazards that can be avoided if recognized and addressed prior to entry. It is designed to eliminate potentially deadly hazards by requiring employers to determine what kinds of spaces their workers are in; what hazards could be there; and how those hazards should be made safe (including the use of headlamps, flashlights, and other lighting equipment that carry the proper safety ratings).

Therefore, in settings where the environment is inherently volatile, headlamps should carry the proper certification for various classes, divisions, and groups of materials. When a headlamp is rated for all these options, it essentially means it is certified as safe for use in most hazardous environments.

"Whether for OSHA, Zone 0, or state standards, intrinsically safe products help safety officials ensure that all the bases are covered. So, there is nothing from the lighting that could spark a potential fire or explosion in a work environment," said John Navarro, a purchasing agent for a wholesale distributor that supplies to various industries including automotive, consumer electronics, oil and gas, and marine. Previously, Navarro was a nationally registered paramedic and certified New Jersey state hazardous material technician.

OFFERING NEW FEATURES

Because headlamps can be dropped or bumped in industrial settings, it is also important that the equipment is designed to reliably withstand rough handling.

In response, some manufacturers now make headlamps with durable thermoplastic material designed to withstand drops and rough handling including being thrown into a truck bed. The units not only provide up to 10 hours of light without a battery change but also have superior resistance to common, potentially dangerous, industrial chemicals and solvents.

The latest models also offer anti-static properties and safety features, such as a mechanical locking mechanism that requires a tool to open the battery compartment. This prevents users from inadvertently opening the battery housing in a hazardous environment, which could not only result in electric shock, but also potentially ignition or explosion.

According to Navarro, the motivation for budgeting and supplying intrinsically safe headlamps and lighting as PPE is to prevent potential liability.

"With an intrinsically safe headlamp, you are meeting the standard and enabling employees to work in the safest possible conditions with the most up-to-date equipment," said Navarro. "Now the technology is at a better price point than it was five years ago. So, it is affordable for corporate safety budgets."

Many of Navarro's industrial customers are willing to spend a little more for higher rated, compliant, intrinsically safe headlamps.

"Our customers want to know their plant personnel can safely use their intrinsically safe headlamps anywhere. Safety committees do not want to worry about where personnel may use the units, if it is safe to use under hazardous conditions," concluded Navarro.

While electrical work carries some inherent risk, facilities seeking to improve safety can do so by providing workers with ultra-safe headlamps that ensure compliance.

So, as the need for worker safety only grows along with stricter regulation, facilities will increasingly make headlamps a mandatory part of any PPE budget or safety program to minimize operational risk and liability. ESW

Dave Cozzone is the VP of Sales for Princeton Tec (www.princetontec.com), a Trenton, NJ-based producer of ETL and UL-approved lighting products and manufacturer of headlamps that meet strict global safety requirements including Classes I, II, III; Divisions 1,2; and Groups A-G.

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How to Choose the Right Electrical Gloves for the Task at Hand

By Richard Rivkin, Contributor

There are several regulatory standards mandating the use of rubber insulating equipment to protect workers from arc flash and electrical hazards. Regardless of the heavy fines, serious injuries, and deaths that occur from electrical incidents, compliance continues to remain an issue. What is even more shocking is that many workers are not using rubber insulating equipment because they do not know they need it, or because they are unsure of how to select the proper personal protective equipment (PPE) for the application.

In reality, almost every single facility has a need for arc flash and electrical safety - whether the company is a larger facility with building engineers overseeing distribution, or a smaller facility with maintenance staff working on or around floor or wall sockets. There is quite a large number of possible end users. As such, awareness is paramount. Not only about the requirements for use, but also about for how to choose the right rubber insulating equipment to protect workers and employers against injury, loss time, costly damage, legal liability, increased insurance premiums, and hefty regulatory fines.

While the best way to prevent arc incidents from happening is through engineering controls such as de-energizing equipment before beginning work, there are instances where turning off the power could create an even greater hazard. Therefore, employers and facility owners must establish safe practices to protect their workers against arc flash incidents including the use of PPE. The NFPA, along with the Occupational Safety and Health Administration (OSHA), mandates and enforces safer electrical work practices under the NFPA 70E standard. Numerous experts and training programs are available to provide guidance on how to keep workers safe and compliant in terms of conducting a proper arc flash hazard analysis. The results of the analysis will usually guide the property owner regarding the controls that should be in place (engineering, mechanical, human, or otherwise) and review the hazards of both arc flash and electrical shock. From there, proper PPE options - such as arc-rated clothing - can be determined. However, one topic that is often not discussed in detail is the need for rubber insulating gloves where a shock hazard exists from exposure to energized equipment.

GLOVING YOUR HANDS

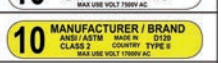
Employees that work on electrically energized circuits and equipment use their hands, making them the most susceptible part of the body to electric shock. Arc-rated work gloves offer no shock protection, and most arc flash hazards have a shock flash hazard as well. Rubber insulating gloves (electrical gloves) are an essential element in protecting workers that are exposed to high-voltage currents. Shock protection is the primary benefit. However, electrical gloves also provide significant burn protection in the event of an arc flash. Electrical gloves are manufactured using proprietary materials and manufacturing processes with 100% testing to provide the highest possible level of protection. To be effective, electrical gloves must incorporate high dielectric and physical strength along with comfort, flexibility, and durability. To help ensure safety and performance, they should meet and/or exceed the requirements of ASTM D120 Standard Specification for Rubber Insulating Gloves.

OSHA rules and the NFPA 70E standard require the use of rubber insulating products when even the smallest probability of contact with 50 volts AC or higher exists. According to the OSHA 29 CFR 1910.137 standard, electrical gloves must be rated for the voltage to which a worker will be exposed (phase to ground or phase to phase) and marked to indicate their rating. For in-service use, the maximum-use voltage must be above the actual exposure, but it is important to take note of the proof-test voltage as well. Electrical gloves are offered in six different voltage rating "classes", based on ASTM D120. All electrical gloves are tested by the manufacturer at the specified proof test voltage.

Manufacturers also perform a dielectric breakdown test at an even higher voltage to validate the dielectric strength of the rubber material. The result is a significant margin of safety between the proof-test voltages and the maximum-use voltage. Each specific hazard assessment will help you determine which class of electrical gloves is appropriate for your application.

Electrical gloves are categorized by the level of voltage protection they provide. Voltage protection is broken down into the following classes, and each class of gloves is clearly marked with the maximum-use voltage on the permanent color-coded label:

ASTM LABELING CHART FOR RUBBER INSULATING GLOVES

CLASS	TEST AC VOLTS	USE AC VOLTS	USE DC VOLTS	LABEL COLOR	LABEL IMAGE
00	2,500	500	750	BEIGE	
0	5,000	1,000	1,500	RED	
1	10,000	7,500	11,250	WHITE	
2	20,000	17,000	25,500	YELLOW	
3	30,000	26,500	39,750	GREEN	
4	40,000	36,000	54,000	ORANGE	

Take care to choose the right glove size, as proper fit will ensure the likeliness that the workers will wear the electrical gloves. Gloves that are too big or bulky can affect tactile sensitivity, while gloves that are too small can cause discomfort. ASTM D120 section 8.2 provides the measurements of the diameter of the palm for manufacturers, measured at the midpoint of the palm, plus or minus a ½ inch. Measure the hand by wrapping the tape all the way around the palm. This number would equate to the probable size of the glove to select. Personal preference for tightness and finger length will ultimately determine the size that the wearer will choose. Electrical gloves are typically manufactured in sizes 8-12, often in ½ sizes, and some manufacturers also offer gloves as small as size 7 and as large as size 13. In addition, electrical gloves are available in different cuff lengths of 11, 14, 16, and 18 inches depending on the glove class.

PROTECTING THE GLOVES THAT PROTECT YOU

With few specific exceptions, electrical gloves must always be worn with leather protector gloves manufactured in compliance with ASTM standard specification F696. The OSHA "269" standard (29 CFR 1910.269) requires that rubber insulating gloves along with leather protectors must be worn by qualified employees within the Minimum Approach Distance (MAD) to exposed energized conductors. That being said, equal care and consideration should also be given when selecting the appropriate leather protector gloves. Leather

protector gloves are worn over electrical gloves to extend their life and provide protection to the gloves from cuts, abrasions and punctures. Use the ASTM F696 standard specifying the types of materials, construction, and other details as a guide in the selection process. Keep in mind that there is a tracking and flashover risk which increases as the voltage potential increases. Since the materials in the leather protector gloves have no dielectric properties and may absorb moisture or at least track electricity, it is important to maintain a gap between the leather protector glove and the wearer's body parts, like the hand and arm. Therefore, the leather protector must be shorter than the rubber glove so that there is exposed rubber as a line of defense against tracking and flashover. The applicable ASTM specifications state that the minimum distance between the edge of the leather protector and the cuff edge of the rubber insulating glove is ½ inch for low-voltage gloves and 1 inch per glove class for high-voltage gloves. Knowing this, the leather protector for a Class 2 electrical glove must be at least 2 inches shorter than the rubber glove.

All in all, electrical gloves are a necessary component to most worker safety programs, as they are the only protective gear designed for constant contact with, and protection from, energized conductors and equipment. All other items are designed for protection from accidental, incidental, or brush contact. Consequently, choosing the correct electrical gloves (and leather protector gloves, too) using the ASTM specifications and standards for class and materials, as well as hand measurements and sizes is key to ensuring worker safety. ESW

Richard A. Rivkin is CEO and Chairman of the Board at Saf-T-Gard International, Inc., a privately held family-owned and -operated global supplier of industrial safety products based in Northbrook, Illinois. Founded in 1936 as Latex Glove Company, Saf-T-Gard carries on the tradition that was started more than 85 years ago: bringing customers the products, training and service they need to keep employees safe in the workplace (www.saftgard.com).

Minimum distances between the edge of leather protectors and the cuff edge of the rubber insulating gloves, according to ASTM specifications.

Q&A with National Safety Apparel (NSA)

For anyone who may not know, what exactly is arc flash PPE and what kinds of items does it include?

NSA: An arc flash is an explosion due to an arcing fault which releases massive amounts of pressure. Sounds can exceed 160 dB, molten metal and shrapnel can be expelled at speeds exceed 700 mph, and temperatures can exceed 30,000°F (hotter than the surface of the sun!). Electrical workers in all different scenarios can be at risk of an arc flash hazard. With such a catastrophic hazard, PPE or personal protective equipment is extremely important. Arc Flash PPE typically consists of some sort of full body suit like a coverall and head protection like a hood that is meant to protect the wearer from the thermal energy of an arc flash.

Arc Flash PPE typically consists of some sort of full body suit like a coverall and head protection like a hood that is meant to protect the wearer from the thermal energy of an arc flash.

PPE CAT ratings go from 1 through 4. What do those numbers mean? Are there specific hazards that call for specific PPE CAT rating numbers?

NSA: CAT (formerly known as HRC) is short for PPE category. These category levels provide a guide for determining the level of protection required for workers facing arc flash hazards. These guidelines can be found in NFPA 70E, the standard for Electrical Safety in the Workplace or determined through a third-party arc flash assessment. Each CAT level is determined by a combination of the tasks being performed, equipment involved, and hazard risk that goes along with that job. CAT 1 requires PPE of at least 4 cal/cm2; CAT 2 is a minimum of 8 cal/cm2; CAT 3 a minimum of 25 cal/cm2; and CAT 4 a minimum of 40 cal/cm2 PPE. For example, panel boards or other equipment rated at 240 volts or below only need CAT 1 PPE, but 600-volt class motor control centers require PPE CAT 4. These details can all be found in the latest edition of NFPA 70E under article 130.

Arc flash PPE includes non-clothing items, like arc flash blankets. What materials are these blankets composed of? How are they used in the workplace?

NSA: Arc flash suppression blankets are used to help protect both workers and other equipment from the hazards of an arc flash. Many times, they are made up of many fabric layers and include fibers like Kevlar, to help with impact from molten metal and shrapnel.

National Safety Apparel offers some arc flash kits that include different combinations of apparel and accessories, like FR coveralls with gloves and a balaclava, or one with a lift front hood that comes with or without gloves. Why combine items into kits? Are they designed for workers who do particular tasks?

NSA: NFPA 70E requires head to toe, 360-degree protection - an arc flash kit is all about convenience. Arc flash kits serve as a one-stop shop to hold all the PPE needed to

perform a task. Most kits include your garments (this could be a coat and bibs, coverall, etc.), head protection (either a full hood or a face shield/balaclava combination), and even hand protection, such as rubber insulated gloves and leather protectors. No two jobs are the same, so NSA offers kits that are completely customizable to your specific job and task needs.

National Safety Apparel is certified to ISO 9001 with design, which allows the company to customize any of its FR or arc flash protective clothing options to meet specific hazards and comfort needs. What is that process like? And what kinds of comfort needs are addressed?

NSA: Customization is our specialty at National Safety Apparel. Different jobs and tasks often require unique or custom solutions. This can be as simple as the addition of a company logo and reflective trim for enhanced visibility, or complex as a whole new design and color scheme. Our in-house design team makes it easy for us to engineer custom solutions to meet a wide variety of needs. Our multiple U.S. factories allow for rapid prototyping and quick responses to changing industry requirements.

How does arc flash protection differ from flash fire protection?

NSA: A flash fire is a combustion of a vapor cloud resulting from the escape of a flammable material, which then reaches an ignition source. While arc flashes are hazards of those working on and around electrical equipment, flash fires are commonly found in oil & gas, labs, and other facilities with combustible substances. Although not as hot as an arc flash, flash fires are also fast moving and extremely intense, typically lasting for 3 seconds or less, and can range from 1000°F to 2000°F! As you can imagine, with these different hazards, PPE will also differ and requires different testing and standard requirements through NFPA 2112.

What kinds of fabrics, treatments, or technologies does National Safety Apparel use to make its FR work shirts, work pants, hoodies, and FR outerwear flame resistant?

NSA: At NSA we offer a wide variety of solutions. Our products utilize a high-quality proprietary fabric as well as fabric from industry recognized brands such as WESTEX by Milliken, DuPont Nomex, and GORE-TEX PYRAD. Both our DRIFIRE and TECGEN brands feature products that utilize proprietary fabrics. DRIFIRE is known for inherently flame-resistant fabrics that offer superior moisture wicking and dry rates. Our TECGEN SELECT work shirts utilize OPF/Carbon-based fibers for high performance and protection.

National Safety Apparel has a line of FR clothing especially for women, including coveralls, shirts, pants, and even under garments. What went into the design and development of FR clothing for women?

NSA: With functional garments, fit is extremely important. Our line of HauteWork garments, as well as our other women's products, were designed by women for women. HauteWork was started by petroleum engineer Jaime Glas who had firsthand experience of receiving men's garments that were oversized and uncomfortable. This led her to start her own brand of FR coveralls, shirts, and pants that were catered to the female figure. ESW

National Safety Apparel is a fourth generation, family-owned business that is proud to manufacture in the U.S. and serve the toughest members of the workforce with six FR clothing brands and three safety brands (www.thinknsa.com).

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Six "Musts" For Working on Or Near Energized Equipment

By David Weszley, Contributor

Electricity is present in every workplace. When it is necessary to service, maintain, or modify an electrical system that is "live," here are six action items that must be addressed:

1. NFPA 70E electrical safe work practices 2021 edition must be used when working on or near energized equipment.
NFPA 70E 2021 requirements must be followed, starting with electrical safety work practices involving 50V or more. The first priority for any company is to de-energize any electrical equipment. Make sure it is in electrically safe condition before working on the equipment. There are steps when replacing a component, such as a circuit breaker or fuse. First, de-energize the equipment. The second important step is to de-energize upstream, where the energy is fed from. Turn off the power and perform lockout tagout (LOTO).

You may think you have de-energized the equipment, but importantly, you need to verify. This is huge. Check with a voltage meter if any energy is still live. This is the only official way to determine a zero-energy state. Try to turn the motor on, if it doesn't turn on, you assume it is off. But energy can be fed from multiple sources or there can be a delayed stoppage. Confirm your assumptions.

What can be done while equipment is energized, such as when troubleshooting, voltage testing, visual inspection? One, wear personal protective equipment (PPE) while doing this work, per 70E requirements. Two, set up an approach boundary surrounding the equipment that is exposed, such as when the cover is off a panel.

There are specifically designated types of boundaries, per 70E -- the limited approach boundary, the restricted boundary, the arc flash boundary. To give a visual warning of the boundary's parameters, put cones, tapes, etc. around whichever boundary is furthest from the equipment.

The restricted boundary is for shock protection, where you can contact the equipment. Within the restricted boundary you need to use insulated tools.

With the limited approach boundary, you're a couple steps back from the equipment, approximately 36 to 42 inches. Bear in mind, you

must wear PPE.

The arc flash boundary is decided by NFPA 70E calculation, or a qualified person comes out and does the calculation. An arc flash boundary can range from six, ten, twenty feet, or more. Completing an incident energy analysis is "boots on the ground" territory. Qualified workers are physically removing covers, looking inside, conducting visual inspection, looking at types of breakers, wire size, and logging that information. That information is compiled and sent to an electrical engineer. He/she then calculates the incident energy number. This is an extremely important assessment, telling you how dangerous the hazard is.

Does every piece of electrical equipment have arc flash potential? No. That is why you get an incident energy analysis completed. The equipment label will tell you the voltage, the arc flash boundary and necessary level of PPE.

2. An Energized Electrical Work Permit (EEWP) is required by every company when work on or near energized equipment is deemed necessary by the company because power cannot be turned off.
An example is not being able to turn off a ventilation system in a hospital critical care unit, or perhaps an alarm system. In cases such as this you must fill out the permit. One section of the permit is called "justification." Here you explain why you are doing work on energized equipment and why it cannot be de-energized. Several signatures (by a qualified person and managers) are required on the form. You need this documentation if someone is injured while working on energized equipment and OSHA, for example, is contacted.

3. To determine if electrical equipment is energized after lockout tagout, you need to use a voltage meter to test it.
You can't rely on a visual inspection. For example, someone working on equipment may ask a co-worker to flip breaker 20 to de-energize it, but the co-worker flips breaker 21. The person working on the equipment cannot distinguish breakers 20 from 21: this is why you verify that there is no voltage on the right breaker or switch.

4. You must use insulated tools in the restricted approach boundary if you are working on energized equipment.
When you are really close to energized equipment while working, say within six inches, anything in your hands within this restricted boundary, a tool in your hand, may come in contact with the equipment. Or you might accidentally drop the tool. If it is not insulated, it will cause an arc flash, blowing up the equipment and yourself.

Here is another example of what can happen: You're tightening a component with an adjustable wrench. The equipment gets loose due to vibration, and the tool handle accidently touches the energized equipment. You get a cross connection causing an arc flash.

5. It is important to understand the types of PPE you need to wear when working on or near energized equipment.
There are two methods to determine required PPE. One, labels on equipment can tell you the results of an incident energy analysis and the distance you must maintain from the equipment. Two, if the equipment does not have a label, you need to use arc flash PPE category NFPA 70E tables (130.7c15a).

An incident energy study is conducted to determine the level of incident energy a piece of equipment has. Not everyone does an incident energy study. If you get a new piece of equipment, you need to do an incident energy analysis. It can be done in-house if you have a qualified engineer, or you can use the services of a third party.

You need to know important electrical numbers. The average person probably will not know these figures, such as available fault currewnt and fault clearing times for breakers. Equipment labeling is extremely helpful. An equipment arc flash label is also extremely useful. Training helps you understand these numbers. If you do not understand, you're going in rather blind to work on or near energized equipment.

Sometimes your task changes while working on electrical equipment. NFPA 70E 2021 edition has been revised to state that when you turn equipment back on; when a circuit breaker has been replaced or maintenance performed, there is a chance an arc

flash could occur when re-energizing equipment. The 70E 2021 edition states you should wear PPE the first time you turn equipment back on.

6. Only a qualified person can enter the restricted approach boundary.
The limited approach boundary can be entered by an unqualified person for training purposes only. The unqualified person cannot touch or feel the equipment. He or she must wear PPE and have their hands to their sides, strictly visually learning.

To obtain the status of a qualified person, workers 1) need to know how to protect himself or others around them from electrical hazards and arc flash; this is a must; 2) they must have electrical safety training every three years, as NFPA 70E is revised every three years; 3) they must have knowledge of the equipment he or she is working on; and 4) they must demonstrate their skills to a designated person from the company; probably the most knowledgeable person, another qualified person. (Who the company designates to be designated person is at the discretion of the company.)

One more point to consider: OSHA inspectors use NFPA standard 70E to educate them on what to look for and to understand when conducting electrical safety enforcement inspections. Compliance officers can and do use the OSHA General Duty Cause to enforce electrical safety in the workplace -- "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." Arc flash or shock are recognized hazards. ESW

David Weszely is the Electrical Safety Instructor and Course Material Developer for SEAM Group (www.seamgroup.com). He is also the company's subject matter expert on NFPA 70E issues.

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Before You Get Started: Things to Consider in Low-Voltage Work

By Tim Kopp, Contributor

The importance of safety and taking safety precautions cannot be overstated when working on or near energized equipment. In low-voltage environments having the proper personal protective equipment (PPE), like safety glasses, insulated gloves and insulating mats, is essential. Additionally, following basic recognized guidelines when using electrical test equipment goes a long way in enhancing worksite safety. These include:

- Having test equipment that has been certified by an independent testing agency, such as Underwriters Laboratories (UL) in the United States and Canadian Standards Association (CSA) in Canada. This certification ensures that the tester has been verified independently to meet the minimum safety standards set by these organizations.
- Ensuring that there are no atmospheric hazards in the measurement area such as combustible gas or other environmental risks.
- Following the old electrician's rule that you should use only one hand when working on live circuits. It helps keeps you from establishing a path for the electricity to flow through your chest (i.e., your heart). An easy way to follow this rule is to use alligator clips on your meter test leads; this allows you to connect to only one portion of the circuit at a time.
- Making sure your test equipment is rated for the environment you are working in for measurement that you are about to take.
- Take the time to make sure that the function switch is set correctly and that your test leads are connected properly.

Another important consideration when choosing the proper test equipment is overvoltage protection. This is the one of the most important safety features a test equipment can have because it helps protects the user from electrical shocks and electrical arcing. Choosing the right tester means understanding what level of voltage protection is needed for a given environment. It's key to remember:

- Category ratings communicate the level of overvoltage protection built into the tester and the environment in which it is designed to be used. The category rating is listed I through IV and each number represents a specific area of the electrical environment.

Regardless of the test equipment selected, it is essential to follow the 3-point test method.

- The category and voltage rating will be marked on the meter, typically near the test lead (voltage) input jacks.

To get into a little more detail, let's look at each category rating and what it means.

- **Category I** is the lowest level of overvoltage protection available. A Category I test instrument is designed to work only on low-voltage signals. This would be the circuit board level of electronic equipment like fax machines, copy machines, etc. It would be difficult to find a piece of test equipment rated this low since it would severely limit its professional use. Most meters are rated at least Category II.
- **Category II** is the local level for fixed and non-fixed powered devices. These are receptacles of long branch circuits where you plug in appliances and portable tools. These are usually single-phase electrical outlets.
- **Category III** is the distribution level or panel. These circuits are usually separated from the Category IV environment by a minimum of one level of transformer isolation. Category III consists of feeders and short branch circuits (less than 30' from the distribution panel) and heavy appliance outlets with direct or "home run" connections to the service entrance. Most professional electricians work in a category III environment daily. Therefore, a professional electrician should consider Category III as the minimum level of overvoltage protection for their meter.
- The highest level of overvoltage protection is **Category IV**. It is the primary supply level, also known as the service entrance, and it includes any outside overhead or underground lines that might be running between, say, a house and a detached garage. Category IV 1000 volts is the highest level of protection specified by the IEC standard.

Regardless of the test equipment selected it is always essential practice to follow the 3-point test method:

1. Use the meter to measure a known energized circuit.
2. Take the measurement of the desired test circuit.
3. Retest the first known energized circuit.

This method protects the user by determining if the meter is functioning properly, if the test leads are in proper operating condition and whether the meter is set to the appropriate function.

Understanding the role proper test equipment, overvoltage protection and the three point test method, as well as precautions go a long way in enhancing the safety of every job site where electrical work will be completed. ESW

Tim Kopp is a Manager of Education and Training at Greenlee, a leading manufacturer of high-quality tools for electrical and utility trade professionals. Learn more at greenlee.com.

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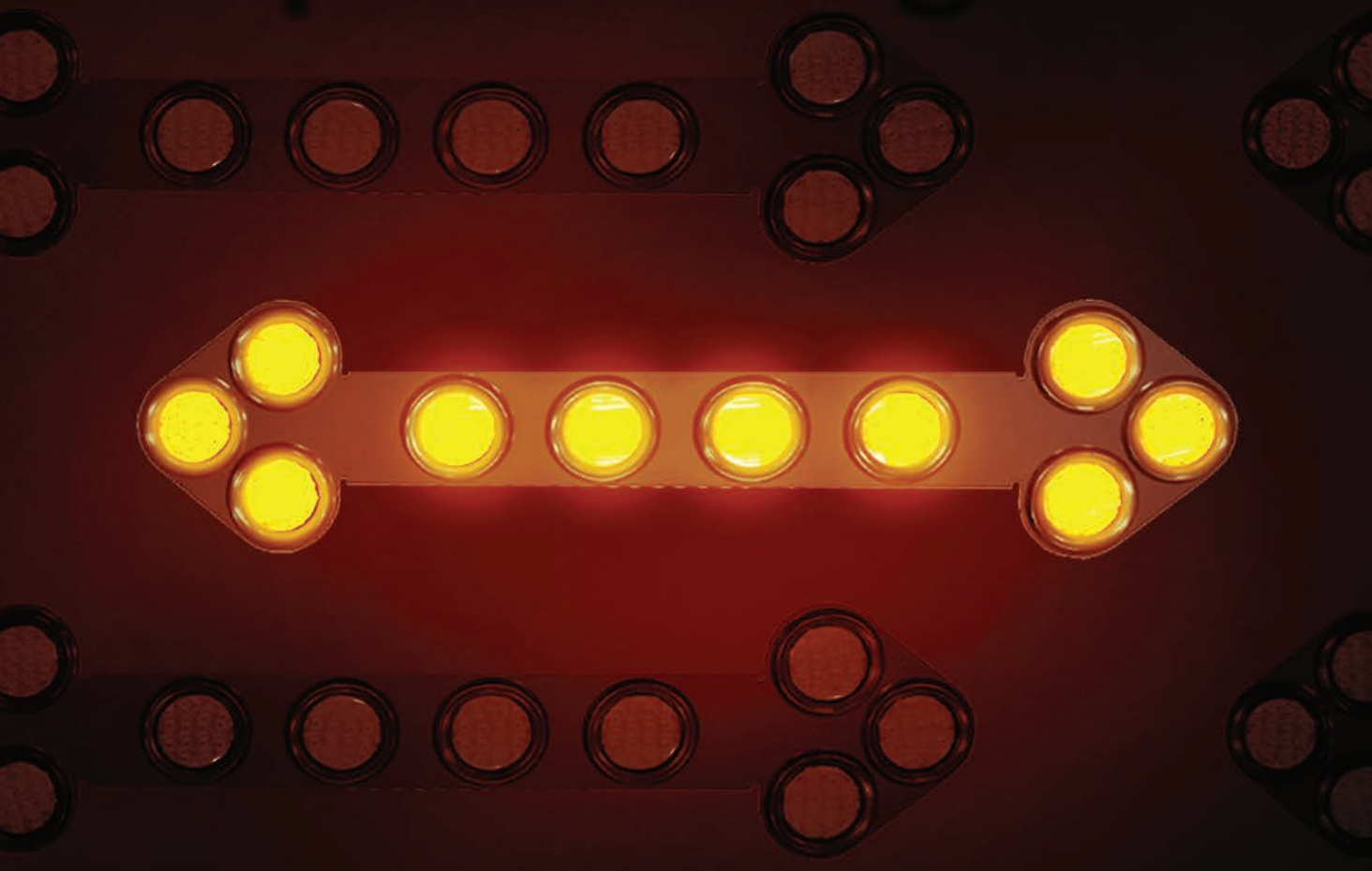

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Five Ways to Know You're Getting a Complete Arc Flash Study

By Dave Hernandez, Contributor

The methods and requirements for arc flash studies are updated frequently, so it can be tough to know and understand what a complete and valid study looks like. On top of that, companies performing arc flash studies don't all put the same resources and personnel into their analysis, so quotes can vary wildly when considering multiple proposals. This can lead to a lot of confusion because many of the quotes don't compare "apples to apples." Some proposals that offer the lowest cost might be lacking key inspections and data collection or might only go as far as the panel level of the power system.

Here are five ways to recognize you're getting a complete and accurate arc flash study:

1. First, looking at electrical schematics is one of the quickest ways to gauge if an arc flash study is thorough. In a true study, a data collection engineer will be on site to gather information from discreet electrical components and analyze electrical infrastructure. The process includes removing panel covers, inspecting cables, and tracing distances. There are a couple of areas to review in the schematics to judge the quality of the study.

   Protective device settings should be accurately shown in the schematic and backed up by supporting data collected by the engineer during the study. Using software helps with calculations, but extra steps are needed to make sure protective device settings are part of the equation and provide the basis for incident energy value of downstream equipment.

   Examining cable distances is another easy way to test the quality of a study. The best arc flash studies accurately document distances by walking out unique measurements for each specific cable. Insufficient studies estimate distances. If the distances on the study are rounded to the nearest tenth or hundredth, they've probably been estimated. For cables to be traced properly, an engineer should measure them with rolling wheels or laser range finders.

   Electrical schematics are one of the driving factors in any complete arc flash study and are one of the most important safety tools, so it's important to have proper and accurate schematics.

2. The second key to a complete arc flash study is the labels. By recognizing the information on the labels, you can determine if a study was performed to the latest and safest standards or if it was done to older standards with fewer safety checks.

   Labels are created using a table method or by specific incident energy calculations, but they can't include both. Labels that provide a PPE category ranging from 0-4 were created prior to 2015 or derived using a generic table method from the NFPA 70E. A true arc flash study uses the incident energy method. Incident energy shows a value on the label in calories per centimeter squared and are based on the IEEE 1584 standard released in 2018. These latest standards include over 1800 tests in 5 configurations, compared to only 300 tests and 2 configurations in the standards released in 2002. Any company performing a proper study should be using incident energy methods and the IEEE guidelines from 2018. More information about incident energy values can be found in the 2021 edition of the NFPA 70E.

3. The third key to a complete arc flash study is to make sure it goes past the panel level. All studies must stop somewhere but many low-cost studies arbitrarily stop at the panel level, which can compromise safety because incident energy is not necessarily lower on the load side of the panels.

   Robust schematics should show feeder devices off of electrical panels. Check for things like 480V local switches, 50 HP motors, or 240V transformer circuits going to air handler units. Make sure machines and control panels specific to your facility are included.

The IEEE 1584 provides guidance on where studies can stop, but it's critical to know that an arc flash study should be done anywhere there are employees working near energized equipment or there's potential to be working on energized equipment rated at 240V or greater or fed from a 125 KVA transformer. Again, accurate schematics will show if these devices are coming off the panels.

4. Mitigation recommendations are the fourth way to know an arc flash study is superior. Mitigation recommendations aren't always required but are a key strategy to improve safety at any facility. An engineer will analyze a completed arc flash study to identify hazards and recommend protective device modifications and upgrades to eliminate, substitute, or reduce hazards.

The Hierarchy of Risk Control Method
The Hierarchy of Risk Control Method starts with the idea that hazards are reduced or removed whenever possible. It's a six-level process including:

1. Elimination - completely removing the hazard
2. Substitution - minimizing the hazard
3. Engineering controls that isolate employees from the hazard
4. Awareness that alerts employees to the hazard
5. Administrative controls that train employees in the best electrical safety practice
6. PPE worn in accordance with labels

Mitigation recommendations can sometimes be compromised by a case of the "fox guarding the chicken coop." Major equipment manufacturers performing an arc flash study might recommend upgrades with all new equipment and devices. It's important to realize many mitigation strategies can be cost effective or implemented for free. It might be as easy as changing instantaneous levels on a breaker. In a lot of cases, instantaneous levels have been left on the highest setting following troubleshooting procedures, but by doing a load study on the circuits and making sure instantaneous levels won't cause nuisance tripping, the level can be lowered to reduce incident energy values.

5. The fifth and final way to know if an arc flash study is complete is a stamp of approval from a professional engineer. All 50 states require that a licensed professional engineer certifies the study in the state where the study is being performed. Some states also mandate firm licensure for the study.

Remember, not all arc flash studies are created the same. To ensure your facility is safe and compliant, it's important to understand that lower cost studies are usually less accurate and might not provide the best safety solutions. Electrical schematics, labels, the equipment being inspected, mitigation recommendations, and proper licensing are the key components that will help you recognize how complete an arc flash study is. ESW

Dave Hernandez, PE, CEM, GBE, CESCP is a distinguished Professional Engineer licensed in 52 U.S. jurisdictions and serves as the Chief Operating Officer at Electrical Power & Safety Co. (https://epsco.co), a world leader in electrical safety. He has overseen over 20,000 electrical projects, sits on various industry committees, and has published several white papers.

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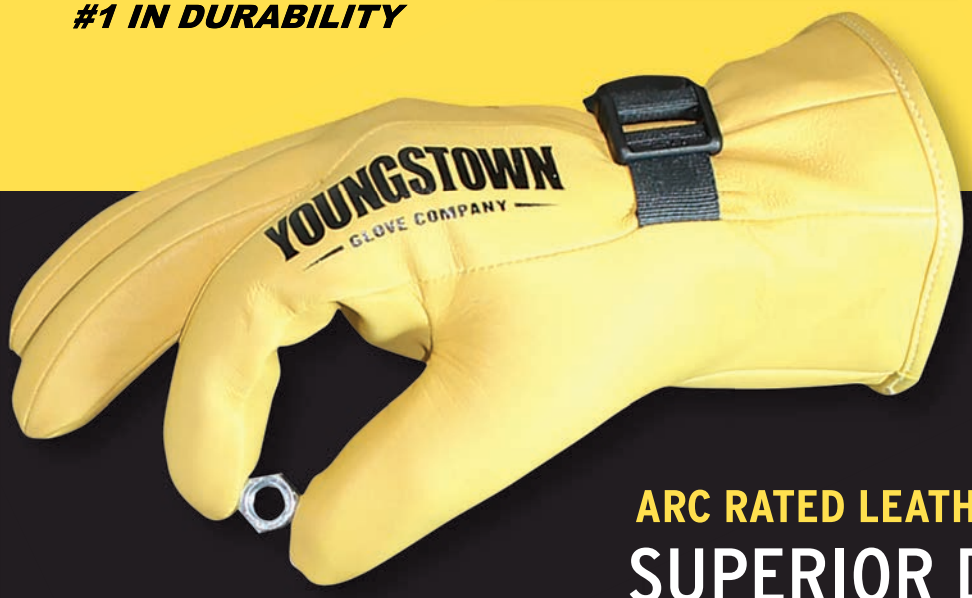

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