Electrical Safety
IN THE WORKPLACE

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Congress Acts on Arc Flash

The Partnership for Electrical Safety

The Partnership for Electrical Safety is very happy to share significant breaking news - the United States Congress has just included very specific language on arc flash and PPE and urged OSHA to act to protect hundreds of thousands of commercial, industrial, and residential American electrical workers from this deadly hazard. The passage is in the FY23 House Labor/Health and Human Services and Related Agencies Appropriations Subcommittee bill which recently passed, and reads:

"The Committee is concerned with continued lack of compliance with OSHA's and industry's standards for arc-flash (AR) clothing and associated personal protective equipment (PPE) requirements that have been in place for over two decades. More than 600,000 American workers performing work on or near energized electrical equipment are exposed to deadly arc-flash related injuries and hazards on worksites across the country without the required lifesaving protection. This results in many catastrophic injuries and fatalities of American workers every year, virtually all of which are preventable. The Committee encourages OSHA to adopt an enforcement policy citing existing standards such as NFPA 70E, and for requiring appropriate arc flash protective clothing and PPE during all live electrical work performed in the United States"

The language itself is obviously highly significant, but so is the bill in which it's found; this bill funds the DOL and OSHA and governs how that money is spent, so the words are magnified by the document.

OSHA has been actively engaged with arc flash safety professionals for over a year, exploring compliance, consequences of non-compliance and options to address the issue and protect workers. Clear signals have been sent around their intent to issue new guidance and possibly updated enforcement as well. While we do not have a crystal ball, we believe areas of new guidance are likely to include clarification on "deenergized" work, risk assessment, NFPA 70E, Arc Rated clothing, and associated PPE, including selection and laundering.

THE MYTH OF "DEENERGIZED"

The myth of "deenergized work" is an issue primarily for commercial, industrial, and residential electrical work in the USA, not utility transmission and distribution. Dozens of workers suffer severe or fatal burns every year as a result. Unless you're pulling wire in new construction not connected to the grid and with no temporary power, some portion of virtually every job over 50V is energized work. The term "deenergized" is widely misunderstood. Deenergizing itself is energized work, as is confirming absence of voltage; when the task is done, reenergizing is energized work, as is confirming the presence of voltage. Lockout/tagout and deenergized are NOT the same thing, and NFPA 70E refers to establishing an electrically safe work condition (ESW) which also involves more than "deenergizing."

OSHA is expected to issue clarification that all work being performed on electrical equipment is considered energized, with all necessary shock and arc flash personal protective equipment (PPE) being worn, unless the employer has conducted and documented in writing a thorough, accurate hazard analysis which

definitively demonstrates that all the steps in the lockout and tagout procedure have been accomplished and that no reasonably adjacent energized equipment poses a hazard.

RISK ASSESSMENT

The number and severity of arc flash burn injuries would be dramatically reduced or virtually eliminated by compliance with applicable OSHA standards and by following the recommendations of National Fire Protection Association's Standard for Electrical Safety in the Workplace, NFPA 70E-2021. 70E has excellent risk assessment tools and tables. While OSHA does not enforce NFPA 70E per se, they regard it as evidence of industry recognition of the hazard, feasible means of abatement, and as the preferred electrical safe work practice standard for substantially all commercial, industrial, and residential electrical work within its scope over 50V in the United States.

Far too many people claim they do not require arc flash PPE because they "do not do energized work." Accurate risk assessment would quickly solve this issue. Deenergized is not the same as lockout/tagout, and most tasks thus described would fall under OSHA definitions of energized work. Equipment and circuits are either energized or they are fully under lockout/tagout. This recognizes that deenergizing is one step in lockout/tagout rather than being considered free of an electrical hazard. See 1910.333(b)(1) which states that "[c]onductors and parts of electric equipment that have been deenergized but have not been locked out or tagged in accordance with paragraph (b) of this section shall be treated as energized parts, and paragraph (c) of this section applies to work on or near them."

ARC RATED CLOTHING AND PPE

Employers can use any of these tables to identify tasks posing arc-flash hazards requiring the use of protective measures, including PPE. Notably, all of these tables include using test equipment on electric equipment and circuit parts as posing arc-flash hazards. Table 3 in the OSHA appendices lists employees holding a conductive object that could contact energized parts as posing arc-flash hazards, while NFPA 70E Table 130.5(C) specifically lists "electrical testing" as having a likelihood of occurrence of arc flash that requires protective measures. OSHA standards (§1910.333(b)) require, and industry practice (NFPA 70E 110.2) recognizes that electric equipment and circuit parts must be treated as energized until the entire lockout-tagout process, including verification by testing that voltage is absent, has been completed. Thus, deenergizing, testing to verify that voltage is absent, reenergizing, and testing to verify that voltage is present are all considered energized work. In short, AR clothing and associated PPE are expected to be provided and worn for the significant majority of electrical work. We also anticipate clarification around task based and daily wear programs, laundering, care, and proper wear.

The road to arc flash protection in the United States began in 1994, when OSHA brought the issue to the utility industry, protecting over a quarter of a million workers. A few years later in 2000, NFPA added arc flash to 70E, and worked closely with OSHA in the process; this should have protected about 1.5 million more workers. OSHA issued two letters of clarification over several years in the early 2000s, and from about 2001-2010, about half of American electrical workers to whom the standard applies were protected. However, little to no progress has been made in over a decade since then to protect the remaining hundreds of thousands of workers. PES applauds Congress for taking action to fix this, and we look forward to updated OSHA guidance which we expect to dramatically reduce injuries and save lives. ESW

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Tools to Enhance Safety in High Voltage Areas

By Ryan Berg, Contributor

Assuring the safety of utility and electrical professionals working in high voltage areas is the first priority on any jobsite. In deciding how best to do that, it is important to not only consider the essential tools and equipment that will help provide protection for the immediate job at-hand, but also considering which tools can be used to enhance an individual's long-term health so they can remain in their careers for as long as they choose.

There are a variety of safety rules that must be followed around high voltage environments, including determining voltage thresholds and minimum approach distances, applying OSHA requirements and the standards and methods of work established by the employer. Each of these influences the necessary personal protection equipment (PPE) needed on a jobsite, but this basic PPE generally includes:

- Fire-resistant clothing
- Insulated boots (OSHA 1910.136)
- Insulating gloves, mats, and blankets (OSHA 1910.137, OSHA 1926.97)
- Hot sticks - an electrically insulated stick (typically fiberglass) with a tool on the end employed for various operations, including testing for high voltage, intentionally grounding conductive surfaces and even performing certain mechanical operations, depending on the tool.

Proximity voltage detectors or high voltage probes are useful in completing the industry recognized three-step verification process of verifying, testing, and reverifying a tool is working properly. Taking time at the start of every high voltage job to go through the three-step process, along with selecting the best tester for the project, will go a long way in assuring work is completed successfully and without injury.

Advances in wireless communication technology now allow work to be carried out from a safe vantage point, removing the worker from the point of danger.

The steps of this process are:

1. Test the detector or probe on a known live circuit or approved testing device to confirm the tool is working properly.
2. Use the detector or probe to verify the circuit that is being worked on or repaired.
3. Re-test the detector or probe on a known live circuit or approved testing device, to confirm the detector or probe is still working properly.

While there is much thought put into jobsite planning for immediate risks that can instantly injure when working around high voltage environments, often regulators and industry leaders fail to consider the long-term safety of workers in the equation to assure employees stay healthy and can continue in their jobs for years to come. One such consideration is ergonomics.

A LOOK AT ERGONOMICS

Ergonomic specialists have been studying the type of jobsite tasks that can contribute to repetitive-use injuries. Their findings, from analyzing jobsite movements like lifting, holding, pushing, walking, and reaching, are being translated into new tools designs to help minimize ergonomic problems. For example, repetitive motions over prolonged periods of time can cause irritation and inflammation of the tendon sheath of the hands and arms, a condition known as carpal tunnel syndrome. The latest tools are designed to work to reduce or eliminate these destructive motions, helping to result in less strain on the body, decreasing the likelihood of injury. Tools addressing repetitive-use issues and other ergonomic concerns include:

- High leverage handle tools – These utilize compound levers or extended leverage handles to lessen the impact and physical exertion on the user's body. For example, come along strap hoists help minimize strain on the body while lifting manhole covers.
- Battery powered tools – Replacing manual,

ratcheting, or hand hydraulic tools with a battery powered option will transform cutting and crimping electrical conductor from one of the most taxing activities on the body into one of the least. These tools not only remove most of the energy needed to accomplish the task, but they can also reduce the range of motion of workers significantly.

- Remotely operated tools – Advances in wireless communication technology now allow work to be carried out from a safe vantage point, removing the worker from the point of danger. For example, remote cable cutters can complete cuts by hand-held remote from a safe distance.
- Vibration or noise damping tools – Looking for jackhammers, tampers, post drivers, and other tools that have built-in damping technology will greatly aid in reducing resulting potential ergonomic issues.

Pairing a few of these new ergonomically designed tools with voltage detectors and standard PPE will go a long way in enhancing the safety of utility and electrical professionals in both the immediate and long-term environments when working on high voltage jobsites. ESW

Ryan Berg *is Director of Product Management at Greenlee, a leading manufacturer of high-quality tools for electrical and utility trade professionals (Greenlee.com).*

Three Simple Ways to Create Arc Flash Boundaries That Protect Workers

By James Strohecker, Contributer

In an arc flash, the most common and most severe injuries are burns. These burns are caused by the extreme heat given off by the runaway arc; the radiant heat that spreads out in all directions.

As a result, NFPA 70E includes a "stay-back" distance intended to limit these burns. The Arc Flash Boundary marks the distance from the equipment at which the Incident Energy of an arc flash would be.

WHAT IS THE ARC FLASH BOUNDARY?

The Arc Flash Boundary determines the distance from the equipment at which the Incident Energy of an arc flash would be 1.2 cal/cm².

The Arc Flash Boundary was developed at OSHA's request by the NFPA to help companies, electrical workers, and employees avoid workplace injuries and fatalities due to shock, electrocution, arc flash, and arc blast, when working in proximity to energized electrical equipment.

The electrical worker has to be able to determine his relative risk, according to the distance from the equipment. The Arc Flash Boundary helps him to determine a safe distance.

Staying outside the Arc Flash Boundary is a way to reduce or eliminate injuries from an arc flash.

1. REQUIRE ARC FLASH PROTECTION

Staying away from the equipment is an easy way to keep safe, but sometimes a worker must get closer to do their work. In this case, the Arc Flash Boundary offers another related benefit; it tells workers when they need specific gear. If workers must cross this boundary to work on the equipment while it is still powered, they need specific personal protective equipment (PPE) to protect them from burns. Failure to use the right PPE can lead to injuries.

The type of required PPE will depend on the work being done, the nature of the equipment, and the available power. Qualified workers, who have the training to safely perform the task in question, should use the information on the equipment's arc flash label to identify the PPE they need. Unqualified workers, who may not be prepared to protect themselves to the same degree, should stay away; they should not cross the Arc Flash Boundary.

2. PROTECT WORKERS FROM ELECTRIC SHOCK

Most equipment that poses an arc flash hazard also presents a risk of electric shock. However, the two hazards need to be addressed separately. Two shock protection boundaries are intended to protect workers from this second hazard.

Limited Approach Boundary is the normal "stay-back" distance for unqualified persons (that is, people without any special training or equipment).

- Qualified persons, who have been trained and equipped for the task at hand, may cross this boundary, if needed.
- Qualified persons may also escort unqualified persons through the area, if appropriate protective equipment is provided for the visitor, as well.

Restricted Approach Boundary is closer and may only be crossed by qualified persons.

- Crossing this boundary to perform work while the equipment is still powered also requires an energized electrical work permit.
- The permit includes a specific plan of action, a list of protective steps to be taken, and supervisory approval.

The Arc Flash Boundary was developed at OSHA's request by the NFPA to help companies, electrical workers, and employees avoid workplace injuries and fatalities due to shock, electrocution, arc flash, and arc blast, when working in proximity to energized electrical equipment.

3. CALCULATE PROTECTION BOUNDARIES

The two shock protection boundaries are based exclusively on the voltage of the equipment and can be found in a set of tables in NFPA 70E. AC systems are covered in Table 130.4(D)(a), and DC systems are covered in Table 130.4(D)(b).

Calculating the Arc Flash Boundary is more complex, partly because the phenomenon of arc flash is still being researched.

- NFPA 70E provides a simplified formula for calculating incident energy.
- IEEE 1584 provides an alternative, empirically based formula, which was developed through laboratory testing and was substantially updated in late 2018.

Most equipment that poses an arc flash hazard also presents a risk of electric shock. However, the two hazards need to be addressed separately.

- For common equipment types and installations, NFPA 70E includes tables that assign Arc Flash PPE Categories and Arc Flash Boundaries. Table 130.7(C)(15)(A)(b) covers AC systems, and Table 130.7(C)(15)(B) covers DC systems.
- All three of the NFPA 70E boundaries are described in this Electrical Safety Boundaries infographic.
- Arc Flash software, such as Arc Advisor or EasyPower, can calculate Arc Flash Boundaries and perform many of the other tasks associated with electrical system analysis.
- Under NFPA 70E, arc flash warning labels must inform workers about the equipment's power level, potential for arc flash, and appropriate personal protective equipment (PPE).
- To provide effective protection from a hazard, perform a risk assessment. NFPA 70E describes a basic risk assessment as having three broad steps: 1. Identify a hazard (a potential source of injury); 2. Estimate the likelihood and potential severity of injuries caused by that hazard; and 3. Determine what protective measures are needed.

Whatever approach you take in your facility, be sure to post these boundaries and train your workers to understand and respect them. And keep your workplace safe with arc flash labeling. Implementing each of these strategies will help to reduce downtime and injuries, and can help improve morale, productivity, and revenue through more efficient worksite operations. ESW

James Strohecker *is the Director of Marketing Innovation at Graphic Products + DuraLabel (https://www.graphicproducts.com). Graphic Products is a leader in delivering innovative design software, industrial sign and label printers, all-purpose floor marking, multi-language signs and labels, and colored pipe markers for any facility's compliance and safety requirements. Learn how to create safety signs that meet OSHA requirements with the Best Practice Guide to Arc Flash Labeling: What You Need to Know. This helpful guide from Graphic Products breaks down all the requirements. The Guide's Do's and Don'ts of Arc Flash hazard equipment labeling list the requirements from the NEC, NFPA, and OSHA, that will help make your operation safe and compliant (www.graphicproducts.com).*

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Outfitting Electrical PPE The Right Way

A Q&A with Rich Gojdics, Senior Vice President of Sales, National Safety Apparel.

HOW DO WE IDENTIFY POTENTIAL RISKS AND THREATS AND WHY IS IT IMPORTANT TO IDENTIFY THESE TO KNOW THE RIGHT ARC FLASH AND ELECTRICAL PPE TO OUTFIT THE WORKER?

Electricians and qualified workers who approach energized electrical circuits and conductors with the intent to engage these systems face the potential for arc flash and electrical shock hazards while in the process of de-energizing the system to perform maintenance or other tasks. These two hazards are different, and the levels of each hazard vary depending on a series of variables. In order to properly protect the worker from each energy level, some information is necessary to match the PPE to the hazard level. Arc flash energies can be calculated in a variety of ways, or workers can reference the Arc Flash PPE Category Tables for guidance in selecting arc flash protection. Shock hazard levels are simply the voltage present in the circuit, and rubber insulating gloves are classified by maximum voltage each protects to.

OVER THE PAST FEW YEARS, A NUMBER OF ARC RATED FLAME-RESISTANT FABRICS HAVE COME TO MARKET. WHY IS IT IMPORTANT TO BUY A BRAND NAME MEETING NFPA 70E PPE CAT2?

This answer has two parts; the minimum threshold to participate in safety PPE is very low and in the case of the Enespro brand, in addition to using branding arc rated FR fabrics, the brand promise is for a better user experience. Workers who like or dislike their PPE have demonstrated over time either strong or weak conformity with the trained rules around when and how to wear their issued PPE.

In order to attain an arc rating, an FR fabric manufacturer only needs to demonstrate that their fabric can be washed a minimum of 25 times before passing the standard vertical flame test. Any fabric passing this minimum threshold can be then tested for the insulative value know as an arc rating, or arc thermal performance value. Given the severity of arc flash events generic fabrics that don't have the in-service pedigree that the branded AR/FR fabrics have demonstrated over time could be substituted by marginal manufacturers, because they sell products that meet existing minimum requirements for arc flash protection. Most employers therefore seek the data and specify the details of both the fabric and garment manufacturers in their programs.

New technologies by proven FR fabric manufacturers continue to drive a better wearer experience in arc rated daily wear and arc flash PPE. Single and multi-layered combinations of fabrics that are lighter, softer, have better breathability, stretch, and quick-dry attributes are helping deliver better comfort to arc rated apparel and PPE. Enespro took additional steps to solve the age-old problems associated with arc flash PPE by collaborating with hundreds of safety leaders and electricians to re-design suit ensembles that overcome the well-known problems of first-generation electrical PPE.

WHAT TYPES OF ARC FLASH AND ELECTRICAL SAFETY NEEDS HAS THE MARKET ASKED YOU FOR AND WHAT HAVE YOU BEEN ABLE TO BRING TO MARKET?

Before Enespro initiated any garment manufacturing, we conducted an extensive research project over a six-month period meeting with hundreds of safety leaders and electricians to understand the top problems workers experience when using arc flash and shock protective PPE. Results of these interviews uncovered user complaints with the categories of head protection, proper PPE

storage, rubber insulating gloves, and most significantly, arc flash suits. Limited innovation in the category of arc flash PPE over time means users largely are using similar systems that were introduced to the market ages ago. Throughout the research project users shared new feature ideas or design changes that would solve their personal concerns and improve the products available to their industry. Enespro and National Safety Apparel together have new arc flash PPE and rubber insulating glove options that help create a safer worker. We confidently say this because the outcomes of these design changes have resulted in ensembles workers readily wear comfortably and have proven to also take better care of. When required PPE is acceptable to the worker, the risks of short-cuts and improvising unsafe work practices is mitigated.

WHAT TYPES OF ARC FLASH CLOTHING AND OTHER PRODUCTS HAS ENESPRO INNOVATED?

Arc flash suits are traditionally heavy and featureless. The Enespro AirLite series in arc-rated levels of 8, 12, and 40-cal suits are both super lightweight and loaded with designs that improve fit, mobility and performance, are easier to don and doff, and include anti-microbial fabrics to reduce offensive odors that are deterrents to proper wear. The National Safety Apparel brand Arc Guard Performance takes weight reduction to the next level, with 40-cal suits that are the lightest in the market, lighter than 12-cal arc flash clothing, and include many of the design options originally added in the Enespro AirLite series.

The head protection options feature the Vented Lift Front hoods with the first combined fanned options available in the market. With clear-grey visibility and large shields, workers have an unobstructed and undistorted view of their critical work. Also, in researching CAT2 complaints, Enespro developed a one-piece shrouded 12-cal shield that eliminates the opportunity for the worker to skip using the balaclava required to accompany the face shield.

PPE Storage has not been the focus of manufacturers of electrical PPE. Common storage bags fit the miscellaneous pieces of arc flash ensembles and hoods or shields, but they provide no structural protection for shields or organization of this gear. Users too often open gear bags to access their gear to discover cracked or broken shields. Enespro's gear bags include a ridged structure within the bag to protect shields while gear bags are in storage, and pockets to isolate rubber gloves to avoid accidental punctures. Recently Enespro's on-going collaboration with customers resulted in small and large backpack options, that free up the hands of the worker to carry additional gear to remote work.

Historical Low voltage rubber gloves complaints have been around loss of grip and dexterity, or poor fit and comfort. National Safety Apparel's acquisitions include a U.S.-made glove capability that delivers a high-quality Class 0 rubber glove that is softer, thinner, and feature a more ergonomically friendly curved finger design that improves the common complaints in fit, grip, and poor dexterity.

EXPLAIN THE ENESPRO NO-OBLIGATION OPPORTUNITY TO TRIAL THE ENESPRO BRAND OF PRODUCTS FOR 30-DAYS BE-FORE MAKING A PURCHASING DECISION.

It's understandable that safety leaders are slow to trust new brands and new technologies where the safety of workers could be jeopardized by a decision to purchase an unknown or unproven brand. Enespro realized that this barrier to market pull through for the next generation of electrical PPE could be resolved if prospective customers had an opportunity to take a

kit for a closer look by safety stakeholders and worn in the field for a brief period to validate the significance of the improved user experience. At the end of the trial period users are either invoiced or return their demo kits without further obligation. With the rapid market buy-in to the overall value of Enespro PPE, it's been a low-risk decision to send users a brand-new kit of their choice, without obligation for a 30-day trial where the vast majority of trials result in new program adoptions.

FROM YOUR PERSPECTIVE, WHAT'S THE #1 ADVANTAGE ENESPRO NOW OFFERS SINCE ITS PART OF THE NSA FAMILY OF BRANDS?

Before joining forces, National Safety Apparel and Enespro shared many of the same values and complementary strengths. Now that we are all one team, we'll have an even greater impact on the world of safety. Both companies have built reputations for high quality and innovative safety products that target solving customer problems. Together we will continue innovating to reinvent the user experience around PPE, not only in the arc flash space but other markets such as FR daily-wear and thermal protection. NSA has spent years developing strong relationships with a vast network of distributors that can now bring the Enespro line of innovative safety products to more end users. Enespro had singular focus on the task-based arc flash PPE market, but now as a part of the NSA family we can also bring a much broader offering of innovative products to the customers that have come to know and trust the Enespro brand. ESW

Electrical Hazards in Solar Photovoltaic (PV) Systems

By Dave Hernandez, Contributor

The use of Solar Photovoltaic Systems is expanding across the country. Safety can be a special challenge for emerging technology like these systems because there are fewer resources available. Understanding the foundations of Solar PV systems will help you better understand the safety protocols that are unique to the equipment.

Solar PV systems generate direct current (DC) power from sunlight. This energy is then commonly inverted to alternating current (AC) to supply loads or is interconnected to electrical grids. The process of transforming DC to AC power is performed through inverters. The energy created can also be transferred to battery packs for storage.

Solar PV systems consist of arrays that are comprised of individually framed PV modules. These modules are electrically linked to generate the voltage and current needed to supply the electrical load.

PV systems can be engineered as standalone or grid connected services. Standalone systems are not connected to an electrical grid, and typically utilize battery storage banks to reserve the energy until needed. Standalone systems operate on DC power. Grid connected services are interconnected with an electrical grid, and supply energy produced from the solar panels to the grid. Owners of grid connected services benefit from metering cost reduction because these services produce power on generation metering with a net subtraction for the amount of power that is consumed.

There are two types of PV systems. In fixed tilt or flat plate systems, PV modules are installed at a fixed angle and orientation, and panels remain in the position they were installed in. They can be installed on rooftops, poles, or the ground. Fixed tilt panels utilize direct and diffused solar irradiance. Tracking or concentrator systems are engineered to track the sun as it moves across the sky, to optimize positioning for maximum solar irradiance. Tracking systems require external cooling components because they are in constant direct sunlight and a significant amount of energy is exchanged.

Code governing Solar PV systems can be found in the National Electrical Code (NEC) article 690. The main electrical section contains details for Solar PV system installation. Also, IEEE Standards 928 and 929 provide engineering recommendations for ground mounted PV systems.

UNDERSTANDING THE POTENTIAL RISKS

PV modules, panels, and equipment can generate significant current and voltage and cause serious injuries. Operating voltages can surpass 600 volts DC, and currents at a sub field level can produce hundreds of amps.

Live parts like exposed conductors, panel connections, busses, and inverter switch gear can cause electrical shocks and burns if they come into contact with skin. Even small amounts of current can be transferred through sweaty hands (a common condition with solar equipment that is located outside). Current higher than 20 mA can flow into the body and pose a severe risk.

The higher the voltage, the greater the chance that current will flow through the victim's body.

High-voltage shock over 440 volts can completely burn away the protective layer of outer skin. Body resistance and lethal currents can cause momentary death. Involuntary muscle contraction in the chest, throat, and

diaphragm can cause respiratory failure. Current that passes through the heart can cause ventricular fibrillation, one of the primary causes of death related to electrical shock.

The best possible method to avoid electrical shock is to follow procedures for establishing an electrically safe work condition (ESWC) as outlined by NFPA 70E standards.

Solar PV systems with battery banks can be a potential arc flash hazard due to the stored energy in the batteries. Shorting terminals from a common 12 V battery bank can generate fault current of over 6000 amps for two-second durations. That energy release can cause serious burns or death if it comes into contact with skin or a person. Exploding battery banks could release lead-acid and cause acid burns on skin or blindness if it comes in contact with the eyes.

As part of the charging process, these systems release flammable hydrogen gas that can be hazardous, so battery banks should be kept in a well-ventilated area. Any flames or devices like controls with relays or switching elements that could create a spark should be kept at a safe distance.

Arc flash hazards may exist in inverter switchgear. This equipment can carry thousands of amps of available fault current because it connects and combines all solar equipment utilized in the DC to AC inversion process.

There are many unique codes designed to specifically govern Solar PV systems.

All conductors and over current protection devices in a PV installation are required to transfer at least 125% of short circuit current or fault current of a PV systems source.

Equipment grounding conductors for Solar PV inverters must be large enough to handle the highest current that could flow through the circuit.

Disconnect switches must be accessible and clearly marked with arc flash hazard information. This can be specific information developed from an arc flash study, or the tables method as outlined in the NFPA 70E.

Solar modules or panels should be wired so they can be removed without interrupting the grounding conductor of another source circuit. This is a safety mechanism that mitigates the need to de-energize when changing out parts.

If fuses are utilized, it's mandatory that power can be disconnected from both ends of either a line or load side of the fuses.

Lightning, ground faults and line surges can produce high voltages even in low voltage installations due to the wiring and DC to AC inversion rates of Solar PV systems. Since they are built in exterior settings, most will experience lightning or storm conditions at some point.

All exposed metal parts should be grounded and bonded to ensure safety in exterior installations.

As Solar PV systems become more popular, it's important to stay current with safety protocols.

Solar provides the best ROI when it comes to renewable energy. Residential and commercial buildings have readily adopted solar technology. It won't be long until Solar PV systems proliferate in the industrial market. ESW

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

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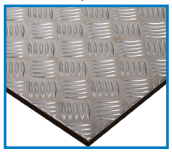

Safety Edges

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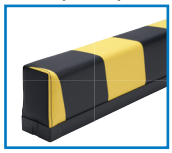

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Future Shock: As the World Goes Electric, Workers Must Be Protected

By Kevin Pietras, Contributor

Electrification is a vital path toward a cooler planet. Widespread electrification could rapidly decarbonize the world by moving it away from fossil fuels.

U.S. carbon emissions could be cut up to 80% by 2035 through swift deployment of existing electrification technologies. McKinsey estimates that half of the fossil fuels used to generate power by industrial companies could be replaced with electricity using technology available right now. Electric vehicles are showing the way as well. Electric vehicle registrations in the U.S. rose 60% in the first quarter of 2022, while total new car registrations fell by 18%.

But the shift to electrification comes with caveats, particularly in the area of safety. As a wide range of factories and industrial parks transition to electrification for their power needs, they will come up against electrical hazards. This will mean more high-voltage electrical lines, and these lines will pose a risk to workers of shock, burns and, in the worst case, fatal electrocution. Already, there are around 30,000 electricity shock incidents and 350 job-related deaths caused by electricity in the U.S. every year, according to the Occupational Safety and Health Administration (OSHA).

As more industries move to electrification, electrical incidents will inevitably rise, and safety measures will be required to mitigate them. That means proper protection will be vital for the increasing number of workers working with electricity every day.

HANDLING ELECTRICITY SAFELY

Workers typically come into contact with electricity through their hands. Injuries happen when they're not wearing the correct gloves. There are three types of hand and arm protections generally used by workers: insulating rubber gloves, leather glove protectors, and insulating rubber sleeves.

Insulating rubber gloves can provide excellent protection against shocks and burns. They do it by blocking the transit of electricity from a source to the wearer. Insulating rubber gloves come in a variety of lengths and hand sizes and deliver various levels of voltage protection by ASTM Class.

When choosing gloves for a job, workers must be aware of the voltage they'll be handling and select their gloves accordingly. Gloves come marked with a voltage rating. In compliance with ASTM standards, the lowest is class 00, which provides resistance up to 500 volts of alternating current (AC) and is proof tested to 2,500 volts of AC and 10,000 volts of direct current (DC). The highest is class 4, which provides resistance up to 36,000 volts of AC and is proof tested to 40,000 volts of AC and 70,000 volts of DC.

Rubber gloves should never be worn without protectors to reduce risk of accidental punctures during a job. Leather provides an essential additional layer of protection on top of insulating rubber gloves. Leather glove protectors can prevent rubber gloves from being torn, cut, or punctured. There should be emphasis here on "additional." Workers should not use leather glove protectors as their only layer of protection or they may be seriously injured, even killed. It's imperative that workers choose and correctly use and maintain the proper protective equipment according to the application and voltage they are working with.

Many workers, such as lineworkers for electrical utilities who come into contact with power lines on the job, need extra protection. For them, insulating rubber sleeves are necessary at a minimum to protect their arms from the wrist to the shoulder in case of accidental arm contact with lines, conductors, and other sources of current. Many utilities and contract workers are adapting rubber sleeves as a standard part of their required PPE programs for lineworkers.

PROTECTING WORKERS FROM THE GROUND UP

Protective footwear is another important element in guarding workers against shocks, burns, and electrocution. The footwear provides insulation if a worker steps on an electrified line or in electrified water. People who work around electricity also face a less-recognizable risk called "step potential." When current flows from a source across soil or flooring, it spreads out in concentric circles. If a worker has one foot in a circle with higher voltage and the other foot in a circle with lower voltage, the electricity will instantly balance by flowing through the worker's body. The worker can be electrocuted without ever stepping on the electricity source or in electrified water.

In all of these situations, electrical workers should have on dielectric footwear for protection. This footwear comes in different shapes and sizes, from dielectric boots to overboots, to overshoes, which are made fit over daily work boots.

As more industries move to electrification, electrical incidents will inevitably rise, and safety measures will be required to mitigate them. That means proper protection will be vital for the increasing number of workers working with electricity every day.

FLASHING RED

Arc flashes are explosions of current escaping

a source and traveling to another conductor or to the ground. They can reach temperatures of 20,000 degrees Celsius, which is almost four times the temperature on the surface of the sun. Workers caught in an arc flash may suffer external burns, internal burns, lung damage from inhaling hot gasses, hearing damage, eye damage, blindness, or death. Around 2,000 workers a year are admitted for treatment of severe burns caused by arc flashes every year, according to the National Fire Protection Association.

Arc flashes happen when there is a short circuit and electricity bursts from its planned path. Given the heat of arc flashes, workers in situations with the potential for an arc flash—such as the repair of an electrical panel—need PPE specially made to protect them.

This PPE must be head to toe. That means coats, bibs, or coveralls made of very heat-resistant materials. It also means arc flash hoods that cover the head and neck, as well as a hard hat and face shield. Face shields should have large, expanded viewing ranges, provide good visibility even in dim or dark rooms, and should have an anti-scratch, anti-fog coating. All arc flash PPE should meet the required calories-per-centimeter-squared rating in accordance with the NFPA 70E standard.

Rubber gloves should never be worn without protectors (such as leather gloves) to reduce risk of accidental punctures during a job.

CARING FOR PROTECTIVE GEAR

Having the right PPE and knowing how to wear it are the first steps in worker protection. The next step is knowing how to take care of the PPE. Proper maintenance, including daily inspection and regular cleaning, is essential.

Cleanliness is essential to ensure that all protective equipment works as intended. Grease, oil, and dirt can inhibit the effectiveness of rubber so it's critical that they're not allowed to accumulate. Rocks, branches, and other sharp objects are common in places where people work with electricity, so workers should regularly check for tears and punctures that limit performance or leave PPE ineffective altogether.

PPE for electrical work must also fit the people who wear it. If it's heavy, cumbersome, and limits mobility, workers are less likely to use it. Too often, PPE is ignored because it hinders productivity. This is why more companies are now investing in PPE that's made with the user experience in mind. And it is why manufacturers are producing better electrical PPE products for all use cases, from more supple gloves to clothing made of moisture-wicking materials that offer enhanced breathability.

The world is shifting to electrification in the fight against global warming and electrical workers are on the front lines, building out the grid and maintaining infrastructure. They need access to the right equipment to keep themselves safe—and keep the planet safe from climate change. ESW

Kevin Pietras *is the Director of Offering Management, Honeywell Electrical Safety (https://sps.honeywell.com/us/en)*

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, these shock hazard boundaries should be determined: limited approach and restricted. 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.

Arc flash boundary 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 arc flash PPE categories must be determined, based on tables provided by the standard. The categories help 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 arc flash boundary, 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: **www.webstore.ansi.org** or even pre-order the National Electrical Code® (NEC®), 2023 edition at **www.catalog.nfpa.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.

Properly documented and implemented Lockout Tagout (LOTO) procedures can help prevent unexpected energization or release of hazardous energy during maintenance activities, saving lives and preventing injury. It is our goal to help our clients provide education for their people on LOTO hazards, prevent near misses and recordables, and create safer equipment servicing and maintenance programs at their facilities.

– SEAM Group
www.seamgroup.com

INCREASE YOUR KNOWLEDGE:

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

Solving Safety Hazards and Shortcomings with Switch-Rated Plugs and Receptacles

A Q&A with MELTRIC.

TELL US A LITTLE ABOUT MELTRIC

MELTRIC is best known for manufacturing industrial UL/CSA listed Switch-Rated plugs and receptacles that feature DECONTACTOR™ technology and push-button circuit disconnection for enhanced user safety and electrical performance. The technology behind our Switch-Rated products was developed specifically to address the shortcomings and safety hazards that occur with the use of traditional plugs and receptacles.

In 1952, following the observation of an accident with a pin and sleeve device, Gilles Marechal devised a device that combined silver-nickel butt contacts and the load making and breaking capabilities of a switch in the convenience of a plug and receptacle. MELTRIC licensed this technology in the early 1980s and has become the North American safety leader in the electrical product manufacturing industry.

MELTRIC also manufactures other safe and reliable industrial plugs and receptacles including multipin, high amperage, single pole, and hazardous location devices. Additionally, we use our devices and third-party components to produce custom power distribution units, including portable rubber boxes, mobile or stationary multigang steel enclosures, dual voltage wall boxes, circuit protected receptacles, and more.

TELL US ABOUT MELTRIC'S SWITCH-RATED PLUGS & RECEPTABLES

Our Switch-Rated plugs and receptacles combine the safety and functionality of a disconnect switch with the convenience of a plug and receptacle. Their exclusive design allows users to safely make and break connections under full load (up to 200 A) and provides significant protection in overload and short-circuit conditions.

They feature a dead-front design and enclosed arc chambers to ensure that the load is safely disconnected and that all live parts are isolated and inaccessible before the plug can be removed. This design guarantees that users are always protected from exposure to live parts and potential arc flash while making and breaking connections.

ARE THEY UL/CSA RATED AND WHY IS THAT IMPORTANT?

Yes, MELTRIC Switch-Rated devices are UL/CSA rated. To achieve their UL 2682 switch ratings, they have passed tests that far exceed those of ordinary plugs and receptacles. These tests include horsepower/locked rotor overload tests from the UL 508 standard for Industrial Control Equipment and electrical endurance and short-circuit make-and-withstand testing from the UL 98 standard for Enclosed and Dead-front Switches.

With their UL/CSA ratings for "Branch Circuit Disconnect Switching" up to 200 A and "Motor Circuit Disconnect Switching" up to 100 hp, they are an approved NEC disconnect switch eliminating the need for ancillary disconnect switches.

WHAT TYPES OF ENVIRONMENTS AND/OR APPLICATIONS SHOULD THESE PLUGS & RECEPTABLES BE USED FOR?

The modular design and numerous mounting accessories of our Switch-Rated plugs and receptacles make it easy to configure them for use in a wide variety of applications. They can be used as in-line connectors/switches, mounted on wall boxes, overhead cord drops in busway systems, distribution panels, or even directly on equipment.

Their modular design makes it simple to install them as "line of sight" disconnects exactly where they are needed. Plus, they eliminate the hassle of finding convenient mounting locations for spacious interlocks and auxiliary disconnect switches required with other connectors.

They have been performance tested for over 6,000 trouble-free operations with highly consistent electrical connections and their critical hardware is made of stainless steel to protect against the effects of corrosion. Reinforced polyester and aluminum alloy casings are used to provide excellent impact resistance as well as protection against UV radiation and most harsh chemicals found in typical industrial applications.

Switch-Rated devices also offer Type 4X/IP69/IP69K watertightness as soon as the plug is latched to the receptacle, or the receptacle lid is closed. These products provide enhanced protection against windblown dust or rain, splashing water, and hose-directed water.

WILL THESE PLUGS & RECEPTABLES INCREASE PRODUCTIVITY, REDUCE DOWNTIME, AND/OR OPERATING COSTS?

Yes! All of the above.

Increase productivity with faster changeouts. Using MELTRIC devices to connect equipment helps to protect users from electrical hazards that are common with hardwired connections and other types of connectors. MELTRIC devices allow qualified persons to safely make/break electrical connections; specially trained electrical personnel may not be required on-site.

Downtime can be reduced by having replacement motors and equipment pre-wired with our Switch-Rated devices. They can be installed with plug and play simplicity reducing change-out downtime by 50%, allowing mission-critical processes to get back in operation faster.

Using our Switch-Rated devices to connect motors and other equipment helps improve your bottom line by reducing equipment, installation, and operating costs. Improved safety reduces accidents, injuries, and related costs. Faster change-outs reduce lost production during downtime. And plug & play simplicity improves maintenance personnel utilization by allowing electrical work to be performed more quickly and conveniently back at the electrical shop.

HOW WILL THESE ELIMINATE HAZARDS AND/OR ARC EXPOSURE?

DS and DSN Series Switch-Rated devices have safety shutters that close over the receptacle contacts before the plug can be removed. Users have no exposure to arcing or direct access to live parts at any time during or after the removal of the plug.

To remove a plug from a receptacle, the plug must be rotated 30° counterclockwise in the OFF position. This rotation of the plug automatically closes and locks the safety shutter, creating an insulating barrier between the plug and receptacle contacts before the plug can be removed.

The safety shutter can only be opened by the insertion and rotation of an electrically compatible plug. Twenty-four

different keying arrangements ensure that only electrically compatible plugs can be inserted into a receptacle.

WHAT ARE THE MOST IMPORTANT TAKE-AWAYS YOU WANT READERS TO KNOW ABOUT YOUR PLUGS & RECEPTACLES?
MELTRIC is dedicated to operator safety. Every electrical device we manufacture is engineered with user safety in mind. Our products help eliminate electrical safety concerns common with other types of plugs and receptacles, including hazards due to exposure to arcing and live contacts, contact degradation, water entry, and terminal failure.

We are committed to quality. All MELTRIC plugs and receptacles are tested and compliant with applicable UL/CSA standards and help users comply with NEC/CEC code requirements as well as NFPA 70E and other safety standards. International configurations are also available and comply with CE and IEC standards. ESW

Anyone who is interested in MELTRIC plugs and receptacles can try out a DSN20 or DSN30 for free! Visit meltric.com/offer to request a sample.

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