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WORK ZONE SAFETY:
HOW TO IMPLEMENT A SAFE AND EFFECTIVE LOCKOUT TAGOUT

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Create a Safe Work Environment with Arc Flash Labeling

By Derek Vigstol, Contributor

It's no secret that arc flash and arc blast are real hazards that present themselves when working with and around electrical equipment. And with regulations, such as OSHA, mandating that workplaces be free from known and recognized hazards, we all have a responsibility to do everything we can to mitigate the risk of injury to employees from arc flash/blast. However, if we are going to protect individuals from the hazards, we might want to have an accurate idea of just what those hazards entail. This means having a rock-solid understanding of the arc flash risk assessment process to determine which strategy is needed to protect the worker.

When it comes to arc flash risk assessment, the truth is that a properly labeled environment is a safer environment than one without arc flash hazard labels. When the safety of an employee is at stake, employers can't be over prepared. There are two options here, perform the arc flash risk assessment ahead of time and label the equipment with the results, or put the responsibility for accurately estimating the risk of injury from arc flash on the shoulders of those doing the work. However, what employers need to keep in mind is that the liability for mistakes during this risk assessment process will not ever fall on the shoulders of the one doing the work but rather will be the sole responsibility of the employer. And often, should the employee make a mistake in assessing the arc flash risk, the employer will have to explain how this individual was even qualified to do this work. The list of reasons why an employer would want to assess this complicated hazard long before an employee is in front of a given piece of electrical equipment could fill an entire article all on its own.

However, there is one specific reason that we need to focus on in particular because in all of my travels, I continue to see a lack of these important safety measures. The reason why employers should label certain equipment? It's a requirement! As an employer, you cannot say that your electrical safety program follows NFPA 70E®: Standard for Electrical Safety in the Workplace® and then not have labels on equipment such as switchgear, panelboards, and motor control centers. Section 130.5(H) in NFPA 70E requires the owner of the electrical equipment to install and maintain labeling on equipment that portrays necessary information for employees to understand the risk that arc flash poses should they perform work when said hazard has not been reduced to a satisfactory level. However, as I mentioned, there is still a significant lack of compliance with this important requirement in NFPA 70E.

How can this deficiency in safety be fixed? We have tried education and awareness, but the needle still has a lot of room for movement and improvement. Many employers view the label required in NFPA 70E as being optional since there is not an entity that forces compliance, such as an electrical inspector will force compliance with the National Electrical Code®. In fact, a former employer of mine did not have arc flash risk assessment labels on any of the equipment within the office building they owned. When I asked why, the building management supervisor said because the 70E labels were not required like the labels in section 110.16 of the NEC®. My response to him was that maybe they should be, and it looks like someone was listening that day.

REVISING SAFETY REQUIREMENTS

The revision cycle for the 2023 National Electrical Code is nearing completion and there is one important change that took aim at increasing the number of facilities with arc flash risk assessment labels. Section 110.16(B) in the 2020 NEC required 1200A

and larger service equipment in other than dwelling units to be labeled with nominal voltage, available fault current, clearing time of service OCPD, and the date the label was applied. The 2023 NEC is expanding this requirement to include feeder supplied equipment as well and the 1200A mark is reducing to 1000A. Those two changes alone are a major step forward for safety. However, Code Making Panel 1 didn't stop there.

The 2020 label only supplied the basic information for the risk assessor to apply the concepts of NFPA 70E, with an exception that allowed labels in accordance with acceptable industry practice to be installed instead. So, what is acceptable industry practice for an arc flash risk assessment label? You guessed it, section 130.5(H) from NFPA 70E. The 2023 revision will now require a label in accordance with this acceptable industry practice. The exception has become the rule.

So, to summarize this revision as to what the 2023 NEC will require, electrical equipment supplied by circuits rated 1000A or more that is likely to require examination, adjustment, servicing, or maintenance will be required, at the time of installation, to be labeled in accordance with applicable industry practice. If we view NFPA 70E as this "applicable industry practice" then the label will require the nominal system voltage, arc flash boundary, and the necessary information to properly select needed PPE either using incident energy analysis or the PPE Category Method. This label is also required to contain the date that the label was applied to the equipment and meet the requirements of NEC section 110.21(B).

This is HUGE! The NEC has dabbled in requiring certain improvements in workplace safety related to arc flash in the past, sections 240.67 & 240.87 both require methods to reduce the clearing time of large overcurrent protective devices during faults. But this is a direct nod to requiring arc flash risk assessment as an installation practice and not leaving it up to the equipment owner to handle after the fact. However, what are the implications of this change for those tasked with turning the words on paper in the NEC into our safe built environment? This requires a little deeper dive into what significance this holds. So, join me for part two of this topic when we look at what this means for the installer and equipment owner up front. ESW

Derek Vigstol *is an electrical safety consultant for E-Hazard and co-host of E-Hazard's electrical safety podcast, "Plugged Into Safety." E-Hazard is the industry leading provider of electrical safety consulting & training services (www.e-hazard.com).*

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Understanding Arc Flash PPE

By Joe Schomaker, Contributor

Nearly all electrical professionals are familiar with the dangers of arc flash – the fiery explosions that can result from arcing faults in electrical equipment.

But did you know employers are required by law to provide exposed workers with the correct level of personal protective equipment (PPE) to safeguard against these potentially deadly events? And non-compliance with this requirement exposes employees to serious safety threats and may result in hefty penalties for employers?

Arc flash hazards are real, and the consequences of wearing insufficient PPE can be devastating. It is critical that facility managers fully understand how to safeguard their employees, infrastructure, and productivity. To provide an introductory guide, this article will explore the various aspects of arc flash PPE compliance, including:

- Applicable electrical safety laws, codes, and standards
- The four levels of arc flash PPE
- Determining what type of PPE is right for your task

APPLICABLE ELECTRICAL SAFETY LAWS, CODES, AND STANDARDS

When it comes to protecting workers from the dangers of arc flash, the following laws, codes, and standards play a key role through continuous research, communications, and enforcement.

- The Occupational Safety and Health Administration (OSHA) is a large regulatory agency of the United States Department of Labor that ensures safe and healthful working conditions for workers by setting and enforcing standards and providing training, outreach, education, and compliance assistance.
- The National Fire Protection Association's National Electric Code (NEC) NFPA 70 provides a regionally adoptable standard for the safe installation of electrical wiring and equipment.
- The NFPA 70E Standard for Electrical Safety in the Workplace is a practical standard that addresses electrical safety-related practices in the workplace.
- The Institute of Electrical and Electronics Engineers (IEEE) 1584 Guide for Performing Arc Flash Hazard Calculations presents methods for the calculation of arc flash incident energy and arc flash boundaries.

Although PPE protects a qualified worker in the event of an arc flash event, it is meant to be used only after recognizing the hazards and taking steps to minimize or eliminate them. The first step in hazard identification and mitigation is to have an arc flash study performed to accurately estimate potential incident energy.

There are two methods that can be used for the selection of arc flash PPE: incident energy analysis in accordance with NFPA 70E 130.5(G) or arc flash category method per NFPA 70E 130.7(C)(15). The incident energy analysis is aimed at calculating how much energy an arc flash could release at various points along the power system. Per NFPA 70E 130.5(G), the analysis must be reviewed and updated whenever changes occur in the electrical distribution system that could affect the results. Additionally, it must be reviewed for accuracy every five years.

Incident energy is defined as the amount of energy at a prescribed distance from the equipment generated during an electrical arc event. It is dependent on the magnitude of

current flowing in the fault and the clearing time of the fault. Accuracy is essential with such measurements, so managers who lack direct and extensive experience with arc flash incident energy analysis should always seek assistance from a qualified power systems engineer.

Upon completion of an arc flash incident energy analysis, companies should place warning labels on all pieces of electrical equipment that pose an arc flash risk. They should also place barriers and signs to prevent or limit access to work areas containing energized circuits and alert workers about electrical hazards that might endanger them.

Although PPE protects a qualified worker in the event of an arc flash event, it is meant to be used only after recognizing the hazards and taking steps to minimize or eliminate them.

DETERMINING WHAT TYPE OF PPE IS RIGHT FOR YOUR TASK

Technicians should never come within the arc flash protection boundary without wearing appropriate PPE such as arc-rated clothing, eye protection, and gloves. These protective layers are available in varying degrees of thermal protection.

If the incident energy analysis method is used, the PPE is selected in accordance with Table 130.5(G), which covers incident energy levels equal 1.2cal/cm^2 up to and including 12 cal/cm^2 and incident energy exposures greater than 12 cal/cm^2. The worker must select all PPE listed in the table and it must have a rating equal to or greater than the calculated incident energy.

If the category method is used, the appropriate PPE category must be determined using Table 130.7(C)(15)(a) or 130.7(C)(15)(b) based on the equipment type or voltage rating. It is important to note that maximum available fault current and fault clearing time must be within the parameters listed in the tables; if they are not met, an incident energy analysis is required. Once the appropriate category has been determined from tables, the arc flash PPE is selected in accordance with the requirements called out in that category.

Table 130.7(C)(15)(c) ranks PPE by four category (CAT) levels. Each of these levels comes with specific arc flash safety requirements.

- CAT 1 requires PPE with a minimum arc rating of 4 cal/cm²
- CAT 2 requires PPE with a minimum arc rating of 8 cal/cm²
- CAT 3 requires PPE with a minimum arc rating of 25 cal/cm²
- CAT 4 requires PPE with a minimum arc rating of 40 cal/cm²

ARC FLASH WARNING LABELS

Equipment labels can warn employees of an arc flash hazard and the proper arc flash PPE required. Per NFPA 70E, section 130.5(H), electrical equipment such as switchboards, panelboards, industrial control panels, and motor control centers that are likely to require access while energized need to be marked with an arc flash warning label that must show the nominal system voltage, the arc flash boundary and information to select the proper PPE. This must include at least one of the following: (1) the available incident energy and corresponding working distance or the arc flash PPE category, (2) minimum arc rating of clothing, or (3) site-specific level of PPE.

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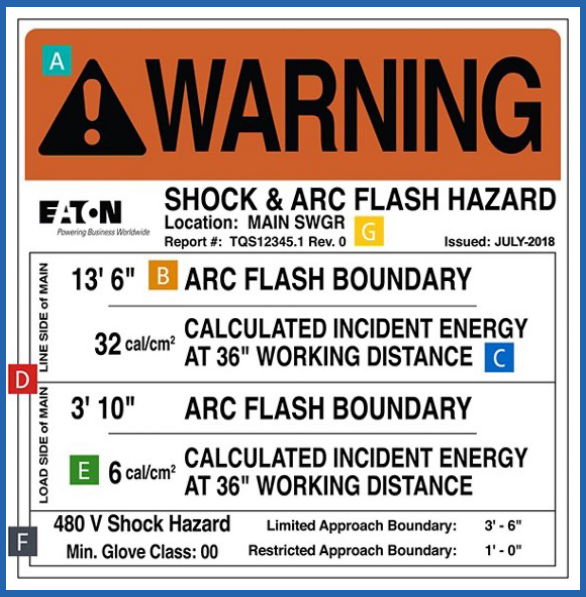
EXAMPLE ARC FLASH WARNING LABEL



A. The owner of the electrical equipment is responsible for providing shock and arc flash warning labels, which are required on electrical equipment over 50V that could be accessed while energized.
B. An arc flash boundary is the distance at which the incident energy equals 1.2 cal/cm^2, and arc-rated PPE is required for any employee within the arc flash boundary.
C. The working distance is the distance from a person's face and chest to the prospective arc source. Typical working distances, primarily based on equipment type, are published in IEEE standard 1584 and used in studies to perform the incident energy calculations.
D. While performing two sets of calculations for the loadside and lineside of the main on specific equipment is not specified in NFPA 70E, Eaton has made this a standard practice to enhance productivity and safety for equipment that has adequate isolation of the main protective device.
E. Calculated incident energy is the amount of thermal energy (cal/cm^2) at a distance from an electrical arc event and indicates the level of PPE required to protect workers from third-degree burns.
F. Nominal voltage, limited, and restricted approach boundaries and PPE glove class are also displayed on the label to help protect workers from electric shock.
G. Eaton's labels display the arc flash study report number for easy reference and label updates.

It is important to understand that voltage alone does not determine the arc flash hazard. Knowing the voltage is only one piece of determining the required arc flash PPE. Many factors, including electrode orientation, available fault current (amps), the working distance between the worker and the equipment, the clearing time of the circuit protection device, the spacing between conductors or from a conductor to ground, the number of phases, whether the conductors are in an enclosure, and the equipment configuration, must all be considered when determining the potential severity of an arc flash hazard.

INCIDENT ENERGY ANALYSIS VS. ARC FLASH PPE CATEGORY

NFPA 70E states two methods can be used in an arc flash risk assessment to determine appropriate arc flash PPE. One is the incident energy analysis method using IEEE standard 1584-2018 calculations, which results in an incident energy value expressed as cal/cm2 at a typical working distance. The second is the arc flash PPE category method, which results in appropriate arc flash PPE selected directly from the NFPA 70E tables.

Using the example arc flash warning label, it appears that the NFPA 70E arc flash PPE category method is a simple lookup. However, to use these tables correctly, additional information such as available fault current, opening time of the overcurrent protective devices, and the working distance is required. First, the available fault current must be known or calculated. Second, the fault clearing time must be known. Table 130.7(C)(15)(a) has an informational note that gives "typical" fault clearing times for different types of overcurrent protection devices. (Actual fault clearing times may differ.) If the available fault current for this example is greater than 25 kA OR the fault clearing time is greater than 0.03 seconds, the arc flash PPE category method cannot be used, and

Example of an IEEE standard 1584 calculation

Bus Name	Device Name	Bus kV	Bus Bolted Fault kA	Device Bolted Fault kA	Arcing Fault kA	Trip Time (s.)	Bkr. Opening (s.)	Ground	Equip	Gap mm	AF Boundary	Working Distance	Incident Energy (cal/cm²)
PANEL-A	PANEL-A FDR	485 mm (19 in)	12.57	12.57	6.56	2	0	yes	PNL	25	6' 2"	1' 6"	13.4

Example of an NFPA 70E arc flash PPE category method

Equipment type	Arc flash PPE category	Arc flash boundary
Panelboards or other equipment rated 240V and below Parameters: Maximum of 25kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	1	485 mm (19 in)

Using the example above, it appears that the NFPA 70E arc flash PPE category method is a simple lookup. However, to use these tables correctly, additional information such as available fault current, opening time of the overcurrent protective devices, and the working distance is required.

an incident energy analysis must completed.

For accuracy, it is important that those who conduct either of these assessments have been properly trained and fully understand the requirements. It is also necessary to have access to a complete, up-to-date copy of NFPA 70E to properly apply the requirements.

PROPERLY PROTECTING PERSONNEL IS CRITICAL

Arc flash events can do significant harm, ranging from disabling or fatal injuries to heavy fines and lawsuits. Fortunately, a wide range of proven technologies and techniques – and thoroughly documented laws, codes, and standards – are available to help organizations reduce or mitigate arc flash incidents and limit arch flash exposure to personnel.

The bottom line is that worker safety should always be the top priority, and if you haven't taken the proper steps to determine what type of PPE is required to protect your workers, you're jeopardizing what matters most.

Stay tuned for the second article in this series, in which we'll explore what to look for when evaluating the many different PPE options across the marketplace. ESW

Joe Schomaker *is a manager of technical sales and marketing at Eaton where he leads a team of application engineers focused on helping customers properly apply overcurrent protective devices (www.eaton.com).*

Why Lockout Is Consistently a Top 10 OSHA Violation

A Q&A with Bill Belongea, Safety Services Program Manager at The Master Lock Company.

Proper lockout/tagout (LOTO) practices and procedures safeguard workers from hazardous energy releases. The OSHA standard for The Control of Hazardous Energy (Lockout/Tagout) (29 CFR 1910.147) for general industry outlines measures for controlling different types of hazardous energy. The standard establishes the employer's responsibility to protect workers from hazardous energy, but sadly it is one of the most violated standards. Bill Belongea, Safety Services Program Manager at The Master Lock Company, shares his insights into why this is the case.

Q: WHY IS LOCKOUT/TAGOUT CONSISTENTLY AMONG THE TOP 10 OSHA VIOLATIONS?

Experts estimate 30% of companies have no lockout/tagout (LOTO) strategy in place, and as many as 90% of companies use inadequate or ineffective measures. Those statistics are especially problematic, knowing that lockout/tagout was ranked #6 in most frequently cited standard violations, with nearly 1,700 violations reported in 2021 alone.

There are a variety of reasons that LOTO is consistently ranked as one of the top-cited OSHA violations, but most often, it's due to the lack of awareness and complexities of the 1910.147 OSHA standard and the belief from businesses that safety procedures and equipment are costly and may reduce productivity.

What's important for businesses to understand is that when LOTO procedures are written and applied correctly, it can improve efficiency and mitigate the risk and cost of employee injuries.

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Q: WHAT CHALLENGES DO BUSINESSES FACE IN COMPLYING WITH THE 1910.47 STANDARD?

Each business is different in the application of lockout. Operators, maintenance, task-based and group are just a few different types of lockout. Understanding what lockout activities occur in your facility will help overcome the roadblocks that prevent buy-in from leadership and turn it into support for lockout. The most common roadblocks that we have encountered include:

- **Lack of Knowledge/Experience**: The early stages of lockout program development and implementation can be challenging as it is, but especially if the company and/or its employees aren't experienced or are simply unfamiliar with OSHA's LOTO standard (1910.147). Traditionally, fewer people participate in LOTO procedures in non-industrial settings like hospitals or office buildings, meaning there may be fewer qualified experts, on-site resources for training and a lack of equipment-specific procedures for the staff to follow. Education and training are key components to the process of implementation of a functioning lockout program to ensure that all parties understand both the safety and legal requirements for 1910.147 compliance.
- **Understanding of Hazardous Energy:** While some hazardous energies are apparent, such as electrical and pneumatic, not all can be seen, such as gravity and thermal energy. It takes an understanding of the types of hazardous energies that can exist on a piece of equipment and how to translate an equipment-specific procedure to fully comply with the 1910.47 standard. Having a third-party evaluate the type of equipment is important to ensure all hazardous energies are well-documented and appropriate LOTO procedures are in place.
- **Perceived Efficiency Barriers:** Some companies may view LOTO as an activity that negatively affects their employees' productivity. However, we've found that most productivity concerns can be overcome by 1) implementing comprehensive and visual lockout procedures at the point of application, 2) training management on their roles and responsibilities to the lockout standard, as well as both authorized and affected personnel effectively and, 3) having the right lockout equipment so you can execute efficient deployment strategies that maximize access to lockout equipment by authorized personnel.

The OSHA standard for The Control of Hazardous Energy (Lockout/Tagout) establishes the employer's responsibility to protect workers from hazardous energy, but sadly it is one of the most violated standards.

For businesses that need assistance in 1910.47 compliance and developing LOTO programs, third-parties like Master Lock's Professional Safety Services offer end-to-end solutions to ensure: OSHA compliance; proven LOTO procedures; and, employee training is adequately implemented, providing both businesses and employees peace of mind.

Q: WHY IS LOCKOUT IMPORTANT FOR EMPLOYEE SAFETY?

It's critical to understand that LOTO is not just

a best practice to prevent worker injury—it's the law. Failure to meet current standards could result in catastrophic incidents, injuries, and in extreme cases, fatality. Operating complex and often powerful machinery is extremely dangerous, and it's the duty of safety managers and other business leaders to ensure employees aren't being put in harm's way.

In addition, a commitment to safe work practices such as step-by-step zero energy isolation lockout procedures will eliminate the potential of production downtime reacting to serious incidents because of not locking a piece of equipment out prior to servicing and maintenance. Incorporating lockout in preventative and predictive maintenance activities is a great way to incorporate a culture of safety throughout your organization.

Q: WHEN REFERRING TO LOCKOUT, WHAT ARE THE TYPES OF HAZARDS THAT WORKERS CAN BE EXPOSED TO?

The term "hazardous energy" encompasses all energy sources, including electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other sources like gravity, in machines and equipment that can be hazardous to workers.

To ensure compliance under 1910.147, all types of hazardous energy sources must

be properly isolated to a zero-energy state through a series of shutdown steps documented by a LOTO procedure. This is essential for employees to control potential dangers and prevent mechanical motion through power generation, or residual pressures during service and maintenance activities.

Q: WHAT INDUSTRIES OR TYPES OF BUSINESSES DO YOU SEE CONSISTENTLY HAVING THE MOST LOCKOUT INCIDENTS?
While the 1910.147 standard applies to many types of work environments, formal lockout practices of paramount importance in any facility where maintenance activities, complex machinery and potential environmental or mechanical hazards abound.

Lockout compliance and procedures are needed in a variety of industrial settings – including manufacturing, food processing, oil & gas, utility, and healthcare facilities, to name a few.

Q: WHAT IS THE RELATIONSHIP BETWEEN MECHANICAL AND ELECTRICAL LOCKOUT?
While the lockout of energy-isolating devices is local to equipment when servicing and maintaining equipment, 1910.147 is a critical resource to understand the responsibilities of the authorized person and organization. When working within electrical devices such as control panels, disconnects, breaker panels and MCC's, the "qualified" worker needs to understand their responsibilities under the NFPA 70E standard.

In most cases when servicing electrical devices, only one hazardous energy source is present – the electricity. This eliminates the

Lockout compliance and procedures are needed in a variety of industrial settings – including manufacturing, food processing, oil & gas, utility, and healthcare facilities, to name a few.

requirement of a lockout procedure for that electrical device. However, strict adherence to the incident energy, PPE requirements and having the skill, knowledge, and training to perform electrical tasks should be part of your electrical safety program. Incorporating lockout requirements for electrical tasks should also be part of your lockout policy.

Understanding the differences between locking out a piece of equipment for mechanical means vs. working on electrical devices puts additional requirements for the worker and the organization.

Q: DO YOU TYPICALLY FIND BUSINESSES LOOKING FOR LOCKOUT GUIDANCE AS A PROACTIVE MEASURE OR A REACTIVE MEASURE WHEN AN INCIDENT OCCURS?

While we have worked with some companies who proactively seek to develop their own custom LOTO program, it's not as common as those who approach us reactively. Many companies will often prioritize other elements of the business and wait until an incident occurs to take their safety procedures and compliance seriously.

At Master Lock, we help customers find the solutions that will allow organizations to understand the importance of lockout. The team consists of safety practitioners, safety managers, and field technicians (that are in many cases ex-Navy Nuclear Electricians) to create the procedures, processes, and trainings within an organization to promote safe lockout and work practices. Because when it comes to safety, there are no second chances. ESW

***Bill Belongea**, Professional Services Program Manager at The Master Lock Company, has nearly 20 years of experience in the safety industry. Belongea has an expansive knowledge in a best practice safety management approach and utilizes his expertise to help facility and factory managers all over the world including Europe, Australia, China, and Mexico. The Master Lock Company offers a broad range of innovative security, safes and safety solutions for consumer, commercial, and industrial end-users (www.masterlock.com).*

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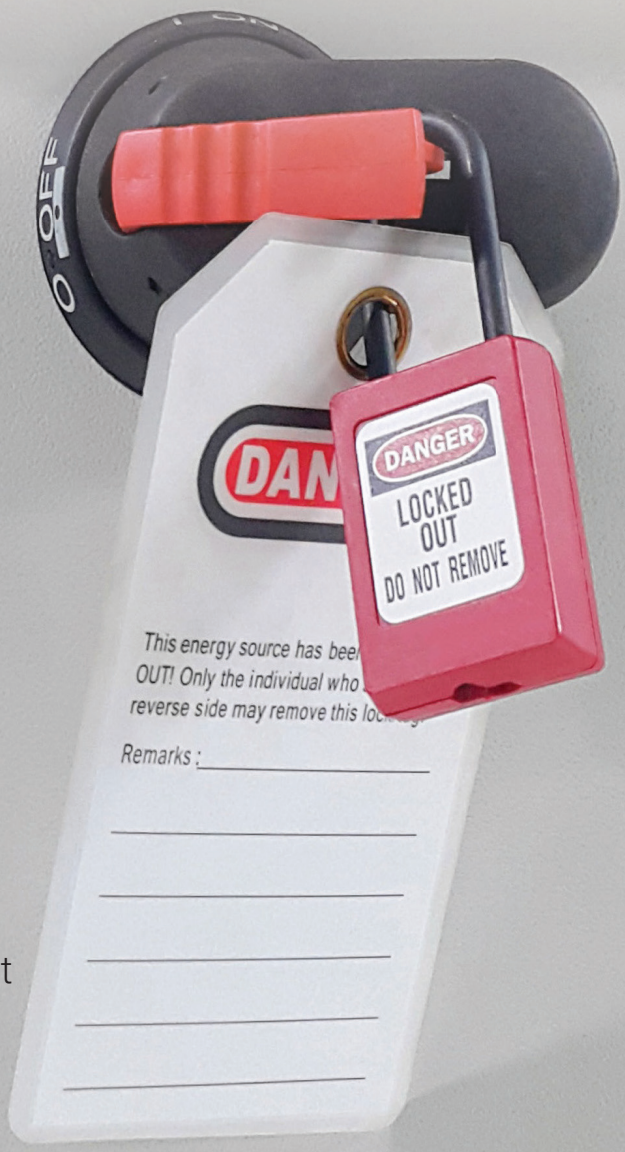

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Work Zone Safety: How to Implement a Safe and Effective Lockout Tagout

By Rick Pedley, Contributor

Before beginning work on your car, you'd ensure the engine was off or it's securely on a jack. The same goes for worksites with a lot of heavy machinery that may need repairs or maintenance. Lockout/tagout (LOTO) procedures can help prevent machines or equipment from energizing, starting up, or releasing hazardous energy during non-routine work like repairs. These procedures also need to be codified to ensure that the process is safe. OSHA's rules for LOTO programs are the best way to ensure that everyone gets home safe at the end of a workday.

If your workplace is one that needs a LOTO safety program, and you haven't yet developed one, get that done as soon as you can. Effective LOTO procedures, at their core, remove energy from equipment completely so that there's no chance of any machinery moving or becoming active while the work is in progress. Incorporating these seven steps can ensure your process is done the right way.

PREPARE FOR SHUTDOWNS IN ADVANCE

Before you ever need to shut down your equipment, everyone around the machinery needs to know how LOTO procedures work. Employees at every level of your organization should have training in LOTO procedures, as well as workplace hazards, including all onsite energy sources. Education and clear communication are a big part of preventing injuries, as well as ensuring that repairs go smoothly, and downtime is minimal.

NOTIFY EVERYONE

Employees whose jobs will be affected by the upcoming shutdown need to be informed. Before the shutdown happens, let everyone know when it's happening and how long the equipment will be down. If the equipment is necessary for completing some tasks, provide reminders of alternate processes, or allocate responsibilities.

SHUT OFF AND ISOLATE THE POWER...

Follow the procedures specific to the equipment in order to cut the power to it. You'll find the procedures in the operating manual. Make sure that the lockdown happens in the safest possible conditions.

Include circuit breakers, valves, and other machinery that supplies energy to your lockdown process. Don't ignore this step, and don't count on everyone knowing the procedure automatically: repairs are non-routine work, and even an industry veteran can forget.

... AND LOCK THE ENERGY SOURCE

This is where you'll need the padlock-like LOTO device that all authorized employees involved in a lockout will receive. This simple tool will physically keep the equipment from being re-energized. The tag on the lock will display who locked the device, when, and why.

RELEASE OR CONTROL THE LEFTOVER ENERGY

Shutting down, isolating, and locking up the energy source will prevent new energy from entering the system, but that's only half the problem. Avoiding accidents will also require that you release the energy that's already there—things like compressed air, capacitors, and compressed springs. Anything that has tension or energy still in it could potentially release it in a dangerous way or restart the machine while work is being done.

VERIFY THE LOCKOUT

There shouldn't be a way to re-energize the equipment while it's locked down and the work on it is not complete. Even if you've followed every instruction perfectly, double check to ensure that your lockout was successful. The failure of a LOTO procedure can be extremely dangerous, so make sure that you've minimized the risk of failure as much as possible.

MAINTAIN LOCKOUT

Never end your lockout prematurely: equipment needs to remain in lockout, and the LOTO device must remain in place until it's safe to fully restore service, including shift change times. Once it's time for the lockout to end, inform affected employees once again about what you're doing and when you're doing it. Clear the equipment, materials, and workers from the dangerous area before you remove LOTO devices and test the equipment.

There's a lot of potential for failure at every step in the LOTO process. Given the serious consequences that can result from failure, minimizing the risk in every way you can is the responsible—and required—thing to do as an employer. It's better to spend time checking that LOTO procedures are done correctly rather than risk downtime, lost productivity, and serious injuries. ESW

***Rick Pedley**, PK Safety's President and CEO joined the family business in 1979. PK Safety, a supplier of occupational safety and personal protective equipment and manufacturer of its own new FR line GRIT, has been operating since 1947 and takes OSHA, ANSI, PPE, and CSA work safety equipment seriously (www.pksafety.com).*

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Your First Aid Kit Is (Probably) Outdated

Every construction site should update its first aid kit by October 15, 2022.

By Nicole Randall, Contributor

The old saying, "Out of sight, out of mind," unfortunately applies to many workplace first aid kits. But there's a good reason to pull existing kits off the wall, out of the closet, or out of the truck, and pop them open for a look before October 15, 2022.

That's when a newly revised industry consensus standard for first aid kits takes effect. Construction site safety teams should review the contents of all their first aid kits to make sure they're in compliance.

The new standard is titled "ANSI/ISEA Z308.1-2021, American National Standard for Minimum Requirements for Workplace First Aid Kits and Supplies."

LAST UPDATE WAS 2015

ANSI/ISEA Z308.1-2021 was developed by the International Safety Equipment Association (ISEA) First Aid Product Group, and approved by key stakeholders representing construction groups, technology corporations, testing laboratories, utility companies, and others. The standard was processed and approved using consensus procedures prescribed by the American National Standards Institute (ANSI).

This is the sixth update since the standard was first published in 1978. The last update prior to this was in 2015. Certain elements of the 2015 update were retained for 2022.

In particular, the new standard kept the kit classification established in 2015 – Class A and Class B – which is based on workplace environment.

- **Class A** first aid kits are intended to provide a basic range of products to deal with the most common types of injuries encountered in the workplace including: major wounds, minor wounds (cuts and abrasions), minor burns, and eye injuries.
- **Class B** kits are intended to provide a broader range and quantity of supplies to deal with injuries encountered in more populated, complex, and/or high-risk workplace environments.

The new standard also details how first aid kits should be marked and labeled, what supplies they should contain, and provides specifications for certain supplies.

Notable changes in kit contents include:

- **Foil blankets:** The new standard makes a foil blanket mandatory for every first aid kit. The requirement reflects international standards and was added because foil blankets can serve multiple purposes, such as treating hypothermia, acting as a windbreaker, and serving as an emergency waterproof wrap.
  Specs: The foil blanket shall be a metalized plastic sheet, having a minimum size of 52 x84 in (132 x 213 cm) and shall be single use.

- **Tourniquets:** The revised standard clarifies types of tourniquets, helping differentiate them from bands used to draw blood (which aren't as effective at preventing blood loss).
  Specs: Each tourniquet shall be at least 1.5 in. (3.8 cm) wide and shall be effective on limb sizes ranging from 7 to 33 in (17.8 to 83.8 cm). Each tourniquet shall be individually packaged as a single-use device, with instructions.
- Bleeding control kits: The 2022 standard offers more guidance on designated bleeding control kits, which contain more advanced first aid supplies to immediately treat life-threatening external bleeding.
  Guidance: Essential bleed control items include chest seal, compression bandage, hemostatic bandages, thermal blanket, and tourniquet.

FIRST AID KIT TYPES

ANSI/ISEA Z308.1-2021 outlines intended uses and specs for four types of first aid kit containers. (Note that Type IV is anticipated for the construction industry.)

- **Type I** first aid kits are intended for use in stationary, indoor settings where the potential for damage of kit supplies due to environmental factors and rough handling is minimal. Type I kits shall have a means for mounting in a fixed position and are generally not intended to be portable.
  - Typical applications for Type I kits may include, but are not limited to, general indoor use, an office setting, or a manufacturing facility. First aid cabinets would generally fall into the Type I classification.
- **Type II** first aid kits are intended for portable use in indoor settings where the potential for damage of kit supplies due to environmental factors and rough handling is minimal.
  - Typical applications for Type II kits may include, but are not limited to, general indoor use, an office setting, or a manufacturing facility.
- **Type III** first aid kits are intended for portable use in mobile, indoor, and/or outdoor settings where the potential for damage of kit supplies due to environmental factors is not probable. Type III kits shall have a means to be mounted in a fixed position and shall have a water-resistant seal.
  - Typical applications for Type III kits may include general indoor use and sheltered outdoor use.
- **Type IV** first aid kits are intended for portable use in the mobile industries and/or outdoor settings where the potential for damage to kit supplies due to environmental factors and rough handling is significant. Type IV kits shall have a means to be mounted in a fixed position and shall meet the performance requirements of Section 5.2.5.
  - Typical applications for Type IV kits may include, but are not limited to, the transportation industry, the utility industry, the construction industry, and the armed forces.

Since kit visibility and identification is crucial, the standard specifies that all labeling and markings shall be legible and permanent. Where adhesive labels are used, they shall not be easily removed. Each kit and/or location shall be visibly marked as a place where first aid supplies are located. The standard also illustrates the information each complete first aid kit shall contain (shown in ANSI/ISEA Z308.1-2021 as Figure 1A or Figure 1B).

TAKE A FRESH LOOK AT YOUR HAZARDS

Each construction site poses its own risks, so every first aid kit needs to reflect the particular hazards and potential incidents at that site. The new standard helps employers assess risks, identify potential hazards, and select additional first aid supplies that are relevant to a particular application or work environment.

"Employers should conduct a thorough workplace hazard assessment to help them determine which supplies to augment," says Todd VanHouten, director of product development and innovation at Cintas First Aid & Safety, and chair of ISEA's First Aid Product Group.

VanHouten says the new standard is a timely reminder to update first aid stations, kits and protocols. Those tasks might seem like nice-to-do's compared to the many must-do's on a busy construction manager's priority list. And human nature leans toward "it won't happen here" thinking. But private industry employers in the U.S. reported 2.7 million workplace nonfatal injuries and illnesses in 2020, according to the U.S. Bureau of Labor Statistics (BLS).

So, staying up to date is more than just a

compliance issue. Being prepared is the smart thing to do.

"The discussions and recommendations in this standard can help guide an organization's overall first aid program, ultimately helping to provide proper and timely treatment for all employees," adds VanHouten.

RESOURCES AVAILABLE

ISEA and its First Aid Product Group produced a free webinar to help employers learn about the updated standard and what's needed to be Z308.1 compliant. A live presentation was held back in May, but a free recording of the webinar, along with other free resources, is available on ISEA's website at: safetyequipment.org/firstaid.

The webinar features recognized leaders in the research and development of first aid treatment items and training, including representatives from Acme United, Certified Safety, Cintas Corporation, and Medique Products.

The standard itself is available for $65 directly from ISEA or through licensed resellers. ESW

Nicole Randall *is the director of marketing and external affairs for the International Safety Equipment Association (https://safetyequipment.org) in Arlington, Virginia, which is the trade association in the U.S. for personal protective equipment, products, and technologies. Its member companies are world leaders in the design, manufacture, testing and distribution of protective clothing and equipment used to protect more than 100 million American workers at construction sites, in factories, hospitals and clinics, farms, schools, laboratories, emergency response and in the home. Since 1933, ISEA has set the standard for the personal protective equipment industry, supporting member companies united in the goal of protecting the health and safety of people worldwide.*

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What Are Absence of Voltage Testers and How Are They Used?

A Q&A with Marty Kronz from Panduit about AVTs and how they boost safety.

The VeriSafe 2.0 Absence of Voltage Tester (AVT) is a permanently mounted tester that is used to verify a circuit is de-energized prior to opening an electrical enclosure. Once installed, a push of a button enables personnel who have been trained on the operation of the tester to verify the absence of voltage and see an active indication when the absence of voltage is confirmed.

Q: HOW ARE VERISAFE 2.0 AVTS DIFFERENT FROM OTHER PRODUCTS?

VeriSafe 2.0 AVT utilizes new technology and has an enhanced set of features making it compatible with even more applications. These AVTs have all the AVT safety and reliability features you know and love, in addition to:

- Network connectivity: monitor voltage levels in real time, record AVT test results, and view AVT status
- Flexible power options: power the AVT test with battery, 24 VDC, or PoE
- Expanded voltage and environmental ratings: including indoor and outdoor applications up to 1000 V, service entrance, hazardous locations
- Optimized configurations: three-phase, single-phase, and DC power systems
- Ability to initiate the test from multiple locations

Whether you choose 1.0 or 2.0, all VeriSafe AVTs provide:

- Increased safety and risk reduction with no exposure to electrical hazards during test
- Increased productivity with results in less than 10 seconds
- Simplified process for easier compliance. The AVTs meet the requirements for permanently mounted absence of voltage testers described in NFPA 70E and CSA Z462

When using a portable test instrument, you must verify the tester is working on a known voltage source.

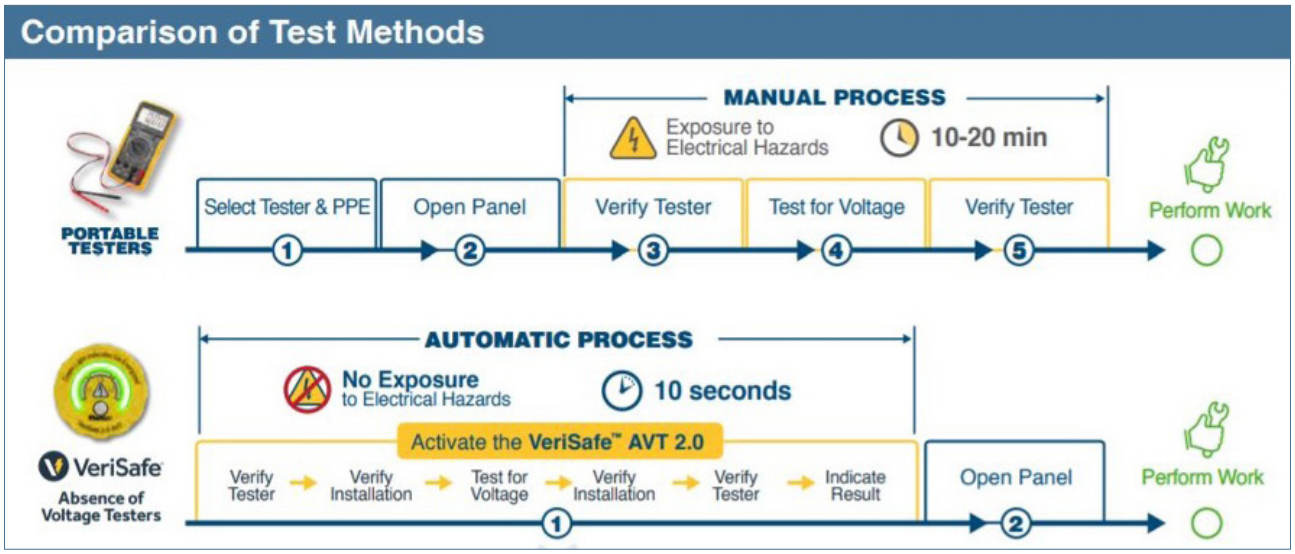
Q: WHERE ARE THE BEST APPLICATIONS, EQUIPMENT, AND PLACES FOR VERISAFE 2.0 AVT TO BE USED?

VeriSafe 2.0 AVTs can be used in even more applications across your facility, from power distribution to automation and motor control. Whether you have an industrial site, commercial facility, utility, or data center, we've got you covered.

AVTs are often deployed in applications where frequent testing for absence of voltage occurs (control panels, motor control centers, switches) or where testing might be considered high-risk (test equipment, power distribution units, switchgear, transformers).

Q: WHY ARE VERISAFE AVTS BETTER THAN PORTABLE TEST INSTRUMENTS FOR ABSENCE OF VOLTAGE TESTING?

When using a portable test instrument, you must verify the tester is working on a known voltage source, open the equipment and make sure the tester probes make good contact with each phase and ground while taking a series of measurements, then re-verify the tester on a known voltage source. This



process is performed by a qualified electrical worker, can be rather lengthy and requires PPE to provide protection for exposure to electrical hazards.

VeriSafe AVTs allow a user to test for absence of voltage before doors and covers are removed. This reduces risk by preventing exposure to electrical hazards. Pushing the test button on the AVT triggers a test sequence that includes using a known voltage source to verify the AVT is working, confirming the AVT has good contact with the test point, and testing for absence of AC and DC voltage phase-to-phase and phase-to-ground. Results are displayed in less than 10 seconds! Permanently mounted absence of voltage testers like the VeriSafe 2.0 AVT are UL listed and recognized as an acceptable method for testing for absence of voltage in NFPA 70E and CSA Z462.

Monitoring voltage levels in real time allows you to detect undervoltage (phase loss) or overvoltage (surge) conditions.

Q: WHO CAN USE VERISAFE 2.0 AVTS?

VeriSafe 2.0 AVTs are designed for anyone who may need to test for the absence of voltage. From mechanical operators to production associates, technicians, electricians, and engineers alike, VeriSafe AVTs make testing for absence of voltage safe and efficient.

Q: EXPLAIN THE AUTOMATED PROCESS OF TESTING ELECTRICAL SAFETY EQUIPMENT AND THE BENEFITS THAT COME FROM IT.

VeriSafe Absence of Voltage Testers:

- Confirm power is available to perform the test
- Checks the health of key circuit elements
- Verifies threshold circuits in tolerance
- Checks on known voltage source
- Verifies connectivity
- Verifies threshold is under 3 Volts

The benefits to VeriSafe AVTs over traditional testing are:

- Built-in known voltage source
- Verifies the tester is contact with the test point

- Keeps hazardous voltage off the door
- Diagnostic codes provide intelligence
- Built-in overcurrent protection
- Automatically self-calibrates
- Recognized by standards and certifications like UL and NFPA 70E

Q: HOW MUCH TIME CAN ELECTRICIANS, MAINTENANCE PERSONNEL, AND OPERATORS SAVE WITH VERISAFE 2.0 AVT? HOW DOES THIS SIMPLIFY ELECTRICAL TESTING?

Using portable test instruments, a typical absence of voltage test may take 10-20 minutes. VeriSafe AVTs provide the same results in less than 10 seconds!

Use our ROI Calculator – find out how much time and increased productivity VeriSafe AVTs can provide you.

In addition, when the VeriSafe 2.0 AVT is used with the Network Module, you can monitor voltage levels in real time. This allows you to detect undervoltage (phase loss) or overvoltage (surge) conditions, while keeping doors and covers closed for troubleshooting.

Q: WHAT POWERS THE ABSENCE OF VOLTAGE TEST?

AVTs must have an independent power source to operate the test and ensure all of the reliability requirements are met when the test for absence of voltage occurs. VeriSafe 2.0 AVTs are designed with flexibility in mind, allowing you to configure the product to best suit your application. Options for powering the test include battery, auxiliary DC, or power over ethernet (PoE).

Q: HOW DOES VERISAFE 2.0 AVT HELP MITIGATE RISKS FOR FACILITY AND PLANT MANAGERS?

Engineers at Panduit leveraged prevention through design principles to reimagine the absence of voltage testing process, looking for ways to remove risk, reduce exposure, and eliminate the most common failure modes and errors that occur when using portable test instruments. The VeriSafe 2.0 AVT is an innovative approach that protects your people, processes, and equipment enabling you to operate safer, smarter, and more efficiently. ESW

Marty Kronz *is Manager of Business Development for Panduit product line – Prevention through Design. (PtD). The vision for this new PtD business is to deliver solutions for control and power distribution applications that reduce electrical workplace hazards through design. In this role, he leads the PtD business team defining its strategy, identifying problems, and developing innovative electrical safety solutions (www.panduit.com).*

Substation Grounding Design: Reducing Step and Touch Voltage Hazards

By David Lewis, Contributor

Substations, switchyards, generation sites, and many industrial facilities have a grounding system that consists of a buried network of ground electrodes. Grounding systems are an important part of the power infrastructure and provide multiple purposes including:

- Helping to ensure personnel and public safety
- Facilitating proper equipment operation under normal and faulted conditions
- Preventing or reducing equipment damage or fault escalation from a power system fault
- Preventing or reducing equipment damage from lightning effects

A grounding study is performed to evaluate a grounding system's ability to reduce hazards for personnel and support power system reliability.

GROUND DESIGN CONCEPTS

During a ground fault, current flows into or out of a grounding system and the electrical potential of the grounding system and surrounding soil are elevated relative to remote earth. This is referred to as the ground (earth) potential rise, and is illustrated in Figure 1.

Bonding and grounding equipment at a site elevates all metallic objects to the ground potential rise. Knowing that current will travel in all available paths, sufficient voltage gradients may be present on the earth's surface to produce catastrophic current to flow through personnel or the public within the affected area. These hazardous conditions arise as voltage varies from equipment to various points of the soil, characterized as touch voltage or step voltage hazards.

As illustrated in Figure 2, a touch voltage is

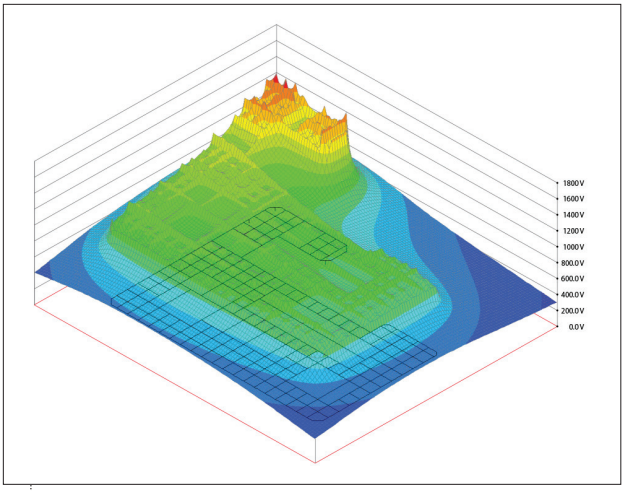


Figure 1: During a ground fault, current flows into or out of a grounding system and the electrical potential of the grounding system and surrounding soil are elevated relative to remote earth.

defined as the potential between the ground potential rise of equipment and the surface potential at the point where a person could be standing while in contact with the equipment. A step voltage is simply the difference in surface potential that could be experienced by a person bridging a distance of 1 m (3') with their feet.

GROUNDING SYSTEM ANALYSIS & DESIGN

A grounding system analysis or study is the evaluation of the grounding system in meeting its design objectives. In the power industry, the primary focus is addressing the aspect of personnel and public safety. IEEE Std 80 provides guidance for safety related to grounding in AC substations. This standard highlights the dangerous conditions that may occur during a ground fault that can severely or fatally injure individuals in the area or in contact with metallic objects. Grounding system analysis and design represent an

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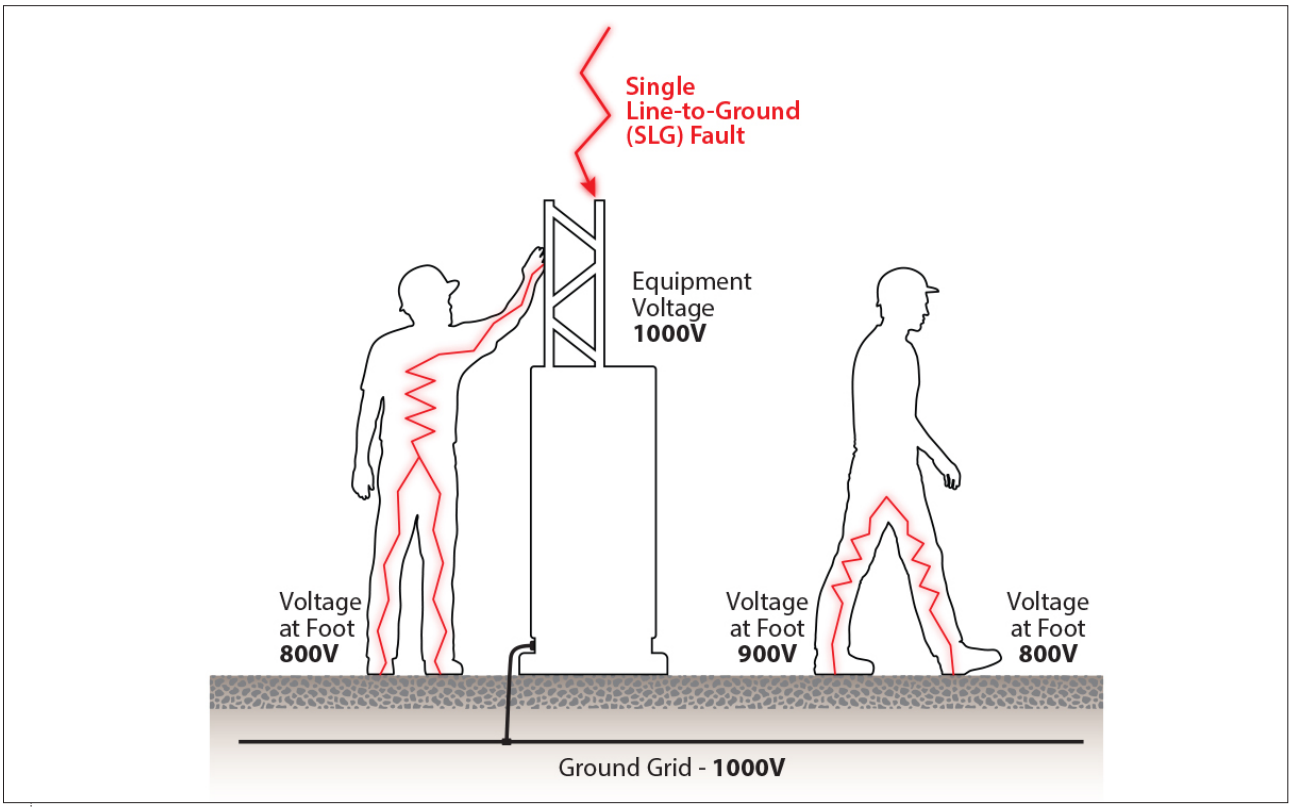

Figure 2: These hazardous conditions arise as voltage varies from equipment to various points of the soil, characterized as touch voltage or step voltage hazards.

engineered control of hazards, as it is impossible to eliminate the risk.

A lower grounding system impedance results in a lower ground potential rise, but designing to a specific impedance, such as 5 ohms or less, is not a measure of an effective grounding system for personnel safety. Determining the touch and step voltages that may occur at a grounding system, compared to the allowable limits, is the correct measure of a grounding system efficacy. Generally, three variables drive the grounding system performance:

- Grounding system physical design and geometry
- Soil electrical characteristics
- Ground fault current magnitude and duration

It is important to note that each component is complex, often varying over time, and significantly affects the conclusions of a grounding analysis. Engineers performing a grounding system study must consider the accuracy of the data and how changes in these variables can affect a study's conclusion. In addition, the design must verify that all equipment is bonded, size the equipment and below grade ground conductors, and possibly evaluate effects on adjacent facilities.

Where analysis indicates allowable voltages are exceeding tolerable magnitudes, there are many approaches to mitigate, such as:

- Expanding or increasing the grounding system to reduce the ground potential rise.
- Installing additional grounding conductor

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- Plastic, die-cast aluminum, or 316 stainless steel bodies are available

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to reduce voltage differences on the soil surface and equipment.
- Adding or expanding a high resistivity surfacing layer material, such as crushed clean gravel or asphalt, to reduce current through the individual on the surfacing.
- Accelerating the clearing time of protective settings to reduce the duration of shock.
- Adding physical barriers to limit access to possible hazardous locations.
- Using personal protective equipment to create equipotential zones and/or increase personnel resistance.

Every station is unique, and the correct approach is an engineering design decision to reduce hazards and limit risks. The IEEE Std 80 was developed for personnel safety within AC substations, but this guide provides the physics and concepts behind grounding system analysis. These concepts are often considered when looking at generation sites, industrial facilities, transmission corridors, and other workplaces to support better studies and promote engineered controls for shock hazards. ESW

David Lewis P.E. *is a Grounding and Power Systems Engineer at EasyPower (www.easypower.com) focusing on electrical studies for power transmission and distribution system analysis.*

Why GFCIs, Prevention Through Design, Need Greater Prioritization

By Tim Piemonte & Rachel Metea, Contributors

Electrical shock is incredibly dangerous. Not only is it dangerous, but it is also a common occurrence where resulting injuries—if not fatal—can lead to lifelong complications.

More than 90% of electrical fatalities among U.S. workers are due to electrical shock[1]. This number does not even include the substantial proportion of injuries and fatalities that are often misclassified under a different cause of death.

Oftentimes, electrical hazards can easily be designed out or controlled with the right equipment. This article will discuss why Prevention through Design (also commonly called safety by design) is the best way to ensure nobody is injured or killed while on the job. This article is part of a bigger report published by Littelfuse.

WHY ELECTRICAL SHOCK INCIDENTS ARE MORE SERIOUS THAN THE DATA REFLECTS

No one is immune from an electrical incident, regardless of their trade. According to data from OSHA, 64 % of all electrical fatalities occur in non-electrical occupations[2]. Thus, companies still have a high risk of fatal incidents from electrical shock occurring regardless of whether mandates require electrical work to be done by qualified workers only.

Industry reports say that electrical fatalities have steadily declined since NFPA 70E became required. This is misleading because it is based on a linear trendline, which is not the best way to understand data that fluctuates from year to year. If we use a 2-year sliding average of these fatality rates, we will see that the electrical fatality rate among workers has nearly flatlined since this rate sharply dropped in 2007.

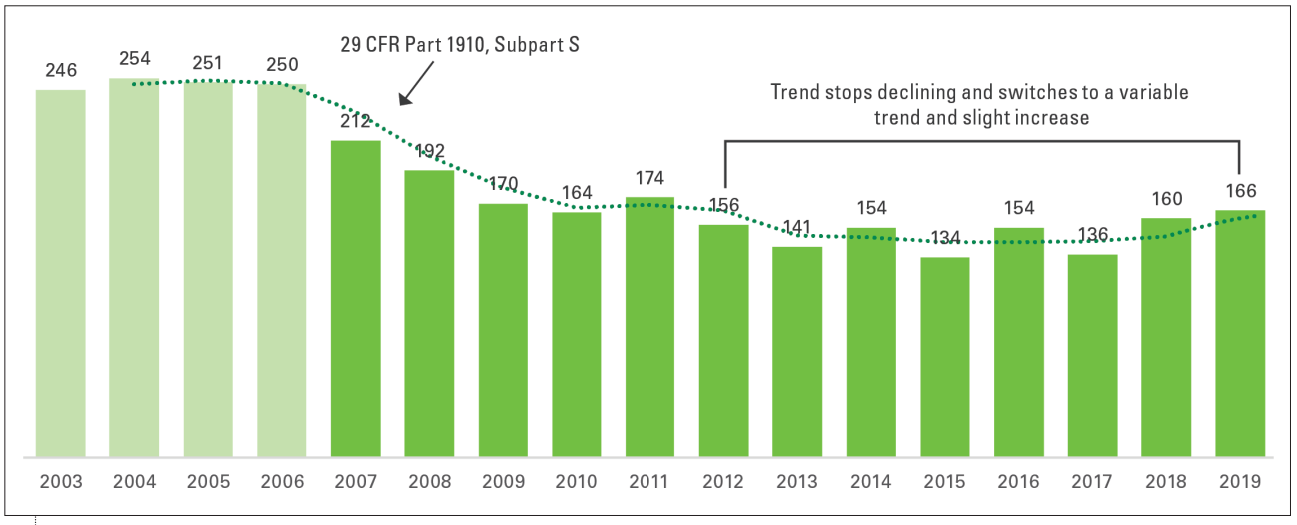
In 2007, OSHA published 29 CFR Part 1910, subpart S, which was the first revision to OSHA's general industry electrical standard in 25 years. The basis of the updates was NFPA 70E-2000 (the previous version used the 1979 edition of NFPA 70E and safety design requirements for electrical installations, such as expanded requirements for ground-fault circuit interrupters (GFCI) protection of temporary wiring used for maintenance and repair purposes (§ 1910.304(b)(3)(ii))[3]. Upon OSHA's requirement for companies to follow better electrical safety designs, the number of electrical fatalities sharply dropped.

In the years following this sharp drop—after most states adopted the new safety standard—the rate of fatalities began to flatline. Thanks to the addition of GFCI requirements in certain applications, the fatality rate is not as high as it once was. However, the current fatality rate shows us that there is still more work to be done—there are more applications where GFCIs can be applied and save lives but are yet to be required by NEC.

WHEN INCIDENTS ARE PREVALENT, A BETTER APPROACH IS NECESSARY

Most companies' current electrical safety approach is not foolproof, particularly among those that rely on PPE and administrative controls (such as safety training). While well intentioned, these methods are prone to human error.

Safety professionals are oftentimes at the forefront of a company's safety approach,



If we use a 2-year sliding average of these fatality rates, we will see that the electrical fatality rate among workers has nearly flatlined since this rate sharply dropped in 2007.

which includes electrical safety. Most safety professionals, however, do not have electrical backgrounds.

This can have two subsequent effects on the company's electrical safety: 1) it shifts the facility's electrical safety approach to focus on safety training and PPE rather than Prevention through Design; and 2) the training's electrical safety component usually becomes lockout/tagout topics, ignoring topics about how to ensure safety in areas that may have long, worn cables or wet environments, for example.

Studies find that even trained workers have a poor ability to recognize electrical hazards. Untrained workers—especially those who work in wet conditions or places where flexible cables are used—are even more at risk. Many studies demonstrate that safety training usually does not adequately cover electrical safety, and of the topics it includes, workers usually do not retain that information.

WHY PREVENTION THROUGH DESIGN, GFCIS, ARE MORE SUREFIRE THAN HUMAN-BASED METHODS

The hierarchy of controls starts with the most effective and moves down to the least effective safety measure. Not all hazards can be eliminated, but the idea is that the closer you get to the top, the safer workers will be.

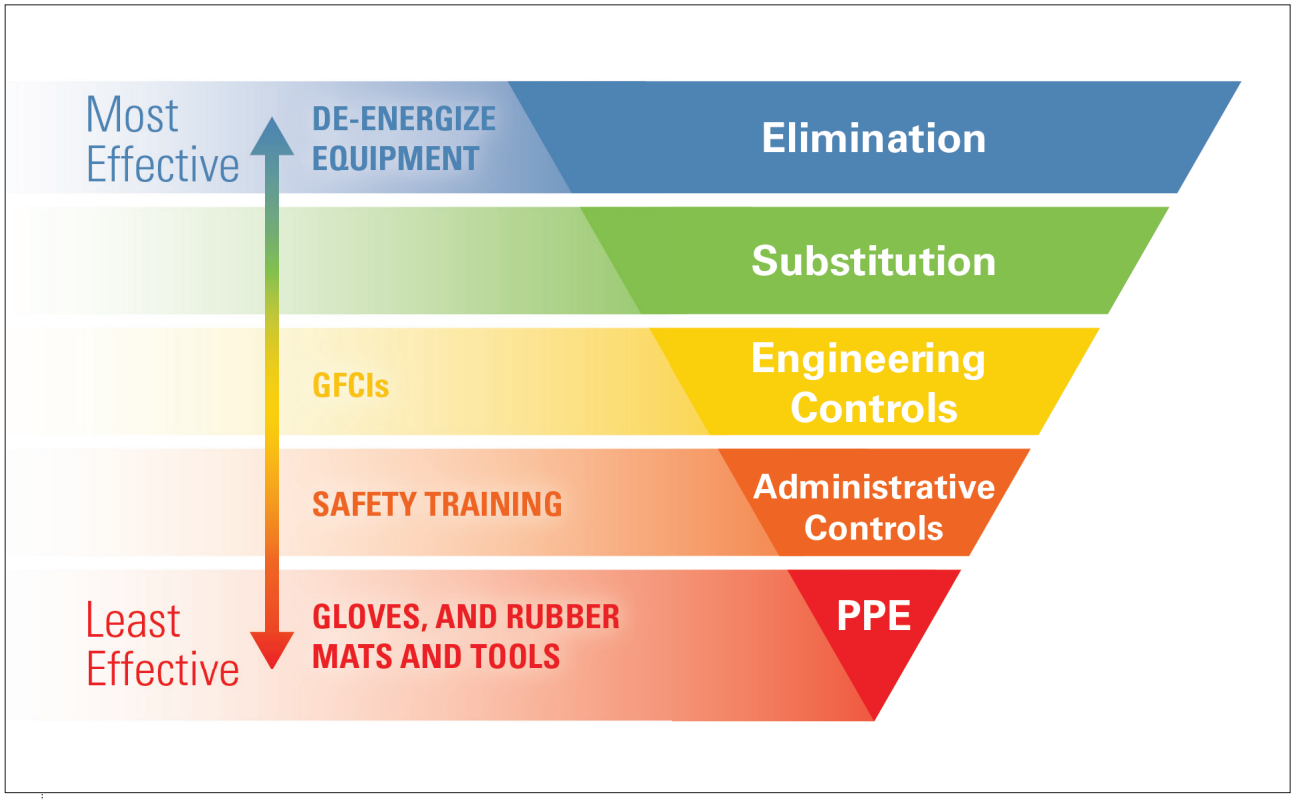
The hierarchy of control's methods are:

- Elimination: Physically remove the hazard
- Substitution: Replace the hazard
- Engineering controls: Isolate people from the hazard
- Awareness: Inform people of possible hazards
- Administrative controls: Change the way people work
- Personal protective equipment: Protect the worker with PPE

NFPA 70E follows the model of the hierarchy of controls. The standard establishes the de-energization of energy sources as the preferred approach to working on or around electrical hazards and emphasizes that PPE should solely be relied upon as a last resort (or an extra layer of protection).

GROUND-FAULT CIRCUIT INTERRUPTERS (GFCIS)

The NEC requires GFCI protection in some



The hierarchy of controls starts with the most effective and moves down to the least effective safety measure.

specific applications, but there are many more hazardous areas where GFCIs should be applied.

For example, control panels that need to be routinely serviced or troubleshot create a hazardous work environment for qualified technicians who must frequently perform live work as a result. The installation of a GFCI in this type of circuit will protect these technicians if they fail to properly follow OSHA 1910.333–Selection and use of work practices. Since a company knows its workers will be frequently working on this piece of equipment while it is energized, they can add GFCIs to ensure no electrical shock incidents occur in the future.

Other examples of places where GFCIs are essential to safety but may not be mandated by electrical codes include:

- Permanently connected equipment in wet or damp areas
- Plug and cord connected equipment in dry but extreme or harsh indoor environments (such as industrial, manufacturing where there is a high level of heat, dirt, and dust)
- Temporary power receptacles other than single-phase 125 volts, 30 amperes and below.
- Any similar permanently connected or plug-and-cord application that is greater than 208 volts (Class C and D SPGFCI applications).

When an electrical designer knows they must put a control panel in a wet environment, they should consider installing a GFCI to

protect the main or a portion of the circuits in that control panel. GFCIs can greatly impact safety when used in control panels where people perform work, along with other places that often require frequent troubleshooting.

If NEC were to require companies to use GFCIs in these applications, the electrical fatality rate may begin to decline as it did when electrical codes were ramped up. GFCIs save lives, so companies should continue to apply them wherever they are applicable regardless of whether they are mandated or not.

Electrical workers often become complacent and take unsafe actions for a variety of reasons. Sometimes it is because they think they know better, while other times it is due to the nature of the task. Electrical safety can easily be missed among workers who are using portable equipment since they are often not provided with adequate safety training, or because the equipment was not protected with a GFCI.

The best Prevention through Design methods involve more than system safety controls—they remove the human interaction element altogether. Out-of-sight, out-of-mind methods, such as GFCIs, operate independently of workers, so they are always safe from electrical shock. If a worker irresponsibly takes their gloves off while using tools, or a safety training course failed to mention the hazards of frayed cables (or if no one noticed the cables are frayed—it happens), workers will still be safe if GFCIs are present. Even with the best safety training and top-of-the-line PPE, these situations could otherwise be fatal.

Oftentimes, the most difficult part of widespread issues is in recognizing that you are among those who can do better. It is not seeing the problem—it is recognizing that you are likely a part of it. The most critical step a company can take to ensure its workers are not seriously injured or killed is to prioritize Prevention through Design. Without proactively taking this step, someone within their company could someday become another electrical fatality statistic. ESW

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IP and NEMA Enclosure Ratings Explained

By Brian Earl, Contributor

NEMA and IP ratings are important factors when selecting NEMA and IEC portable power devices and enclosures to meet your specific product application. Selecting the proper enclosure, or wiring device rating, is critical to the overall safety and protection of work environments.

First a couple of definitions to terms mentioned above –

NEMA – the National Electrical Manufacturers Association and IEC – the International Electrotechnical Commission rate various products, which corresponds with product specification and intended use.

Ratings –

- NEMA Enclosure Ratings are based on "NEMA" types from ANSI/UL50 & UL508
- Ingress Protection ratings (IP) have characteristics define by the IEC per Standard 60529

NEMA Enclosure Type Designations – 1, 2, 3, 3R, 3S, 4, 4X, 5, 6, 6P, 12, 12K, and 13 offer guidance on the Intended Use of a particular enclosure and wiring device. For example, NEMA 6P is defined as "Indoor or outdoor use primarily to provide a degree of protection again hose-directed water, and the entry of water during occasional temporary submersion at a limited depth and damage from external ice formation.

IP Rating System offers guidance in a two-digit format in similar fashion. This rating system is presented in a Grid with an X and Y axis with first and second digits. An example of a similar IP Rating – IP67 where the first digit (6) outlines "Protection against persons – touching and ingress of solid foreign objects" and the second digit (7) outlining "Protection against effects of immersion in water under defined conditions of pressure and time."
In some countries withing the confines of IP ratings, there is a third digit, for mechanical security, is added.

Comparison of "NEMA" Type and "IP" Code designations and Conversion of "NEMA" Type to "IP" Code designations*. (Please notice the above example of Nema 6P and IP67 and the chart below to compare and convert NEMA to IP Code designations.)

IP69K – A recent edition to the IP Code - DIN 40050-9 extended the more recent IEC60529 rating with a IP69K designation for high-pressure, high-temperature washdown applications. This designation was originally developed for road vehicles that need regular intensive cleaning, such as concrete mixers and dump trucks. It has found application to other industries such as food processing, food processing equipment cleaning, and car wash systems.

Using both NEMA Environmental rating for Enclosures and IP Ratings as a guideline for the degree of environmental protection provided by electrical enclosures against corrosion, intrusion chemicals, dust, water, directed spray, and accidental contact are very useful resources to ensure your workspaces are safe and compliant.

Type Number	IP Designation
1	IP10
2	IP11
3	IP54
3R	IP54

Comparison of "NEMA" Type and "IP" Code designations and Conversion of "NEMA" Type to "IP" Code designations*. (Please notice the above example of Nema 6P and IP67 and the chart below to compare and convert NEMA to IP Code designations.)

Environmental ratings for enclosures based on "NEMA" Type designations

"NEMA" Types From UL50 & UL508

Enclosure Type Designation	Intended Use and Description
1	Indoor use primarily to provide a degree of protection against limited amounts of falling dirt.
2	Indoor use primarily to provide a degree of protection against limited amounts of falling dirt and water.
3	Outdoor use primarily to provide a degree of protection against rain, sleet, wind blown dust and damage from external ice formation.
3R	Outdoor use primarily to provide a degree of protection against rain, sleet, and damage from external ice formation.
3S	Outdoor use primarily to provide a degree of protection against rain, sleet, windblown dust and to provide for operation of external mechanisms when ice laden.
4	Indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, hose-directed
4X	Indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, hose-directed water, and damage from external ice formation.

Example of truncated NEMA and IP Code Designations. Note – These tables cannot be used to convert "IP Codes to "NEMA" Types.

Safe Connections through NEMA and IEC Configurations

By Brian Earl, Contributor

NEMA – National Electrical Manufacturers Association developed standards for safe, non-interminable connections through their NEMA Wiring Device Configuration Chart. Similarly, IEC, The International Electrotechnical Commission, developed standards for all electrical, electronic, and related technologies to ensure safe connections.

We'll start with NEMA Wiring Devices and their category definition - Wiring devices are current-carrying electrical or electronic products that serve primarily as a connection or control point for electrical circuits within a range of 0–400 amperes, 0–600 volts (AC and DC), and AC/DC (660 watts, 1,000 volts AC fluorescent) as well as certain non-current-carrying wiring devices and supplies.

NEMA wiring device categories include:

- Convenience plugs and power outlets (plugs and receptacles)
- Connector bodies and flanged outlets
- Cover plates
- General-use switches and dimmers
- Lampholders (incandescent, fluorescent, cold cathode, neon, quartz lamps, and others)
- Lighting control devices
- Motion sensing and timer switches
- Receptacles
- Switch, outlet, FM/TV, blank, and telephone plates
- Undercarpet premise wiring systems

Products include other safety devices like receptacle-type GFCI (ground fault circuit interrupters and recently arc-fault circuit interrupters (AFCIs), protection devices that can detect an unintended electrical arc and disconnect the power before the arc starts a fire. AFCI technology in residential and commercial buildings is an important electrical safety device.

We'll focus our attention on NEMA wiring devices that are designed for commercial and industrial grade, locking and straight blade plugs, connectors, inlets, and outlets.

NEMA has established straight blade configurations, from 15-60A, 125-600V and locking configurations, from 15-60A, 125-600V. (Note NEMA 50 & 60A locking configurations, although established, are currently inactive. Most manufacturers use industry accepted, non-NEMA, configurations at those higher amperages). There are 26 different configurations for both straight blade and locking devices. The NEMA configuration configurations also include Canadian 347V (typically used as a lighting voltage, like 277V, however derived from 600V) and 415V (most often use in Data Center Applications). The intent of these configurations is to provide standard and guidance for safe electrical connections by amperage and voltage to prevent intermating various voltages and amperage configurations that would cause an unsafe condition. There are also locking configurations for Midget Locking, DC voltage, 400Hz, Marine Ship to Shore, and Travel Trailer (straight blade) connections for special applications.

How to read and select the proper configuration from a NEMA configuration chart - start by identifying the blade configuration and selecting the proper configuration from either the straight or locking charts.

What do wires and poles on the chart refer too? Wires are the total number of wires used in a configuration while poles relate to the number of current carrying poles. For example, a popular 2-pole, 3-wire device commonly seen in residential applications has three wires – hot, neutral, and ground. While a 4-pole, 4-wire, uses 3-phase conductors and a neutral, without a separate ground. This is true for both straight blade and locking configurations, which share the same NEMA Number. The only difference is that Locking Device

NEMA Configuration Cross Reference:

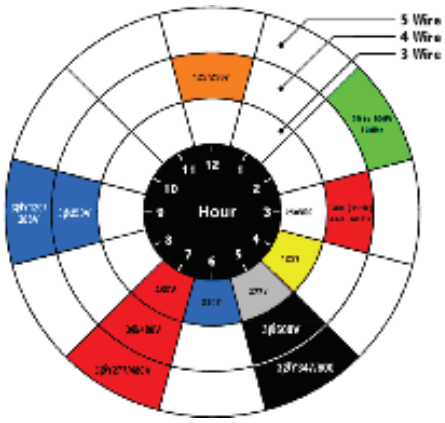
	Face View	NEMA Configuration	Amperage	Voltage	Perma-Link Plug	Competitor H & L	Competitor W	Perma-Link Connector	Competitor H & L	Competitor W
2-Pole / 3-Wire		NEMA 5-15	15A	125V	1510-P*	5266-C	1447	1610-C*	5269-C	1547
		NEMA 5-20	20A	125V	1512-P*	5366-C	1433	1612-C*	5369-C	1533
		NEMA L5-15	15A	125V	1520-P	4720-C	2447	1620-C	4729-C	2547
		NEMA L5-20	20A	125V	2310-P*	2311	2647	2410-C*	2313	2747
		NEMA L5-30	30A	125V	2510-P	2611	2847	2610-C	2613	2947
		NEMA 6-15	15A	250V	1514-P	5666-C	1449	1614-C	5669-C	1549
		NEMA 6-20	20A	250V	1516-P	5466-C	1448	1616-C	5469-C	1548
		NEMA L6-15	15A	250V	1522-P	4570-C	2449	1622-C	4579-C	2549
		NEMA L6-20	20A	250V	2312-P*	2321	2648	2412-C*	2323	2748
		NEMA L6-30	30A	250V	2512-P	2621	2848	2612-C	2623	2948
		NEMA L7-15	15A	277V	1524-P	4770-C	2434	1624-C	4779-C	2534
		NEMA L7-20	20A	277V	2314-P	2331	2649	2414-C	2313	2749
		NEMA L7-30	30A	277V	2514-P	2631	2849	2614-C	2633	2949
3-pole 3-wire		Non-NEMA[1]	20A	125 / 250V	2316-P	7567CY	2608	2416-C	7565CY	2708
		Non-NEMA[1]	20/10A	250 / 600V	2317-P		2708	2417-C		2808
		Non-NEMA[1]	15/10A	125 / 250V	1507-P		2407	1607-C		2507
3-pole / 4-wire		NEMA L14-20	20A	125 / 250V	2320-P	2411	2674	2420-C	2413	2774
		NEMA L14-30	30A	125 / 250V	2520-P	2711	2874	2620-C	2713	2974
		NEMA L15-20	20A	250V / 3-phase	2322-P	2421	2775	2422-C	2423	2875
		NEMA L15-30	30A	250V / 3-phase	2522-P	2721	2875	2622-C	2723	2975
		NEMA L16-20	20A	480V / 3-phase	2324-P	2431	2676	2424-C	2433	2776
		NEMA L16-30	30A	480V / 3-phase	2524-P	2731	2876	2624-C	2733	2976
		NEMA L17-30	30A	600V / 3-phase	2526-P	2741	2877	2626-C	2743	2977
		Non-NEMA[1]	20A	120 / 208V	2326-P			2426-C		
3-pole 3-wire		Non-NEMA[1]	30A	125 / 250V	2516-P	3331	2808	2616-C	3333	2908
		Non-Nema	250/600	250 / 600V	2317-C			2417-C		
4-pole 4-wire		NEMA L18-30	30A	120 / 208V 3-phase wye	2530-P	2751	2609	2630-C	2753	2709
		Non-NEMA[1]	30A	120 / 208V 3-phase wye	2528-P	3431-C	2809	2628-C	3433-C	2909

configurations start with an L – for example a 5-15 and L5-15 have the same connection configurations.

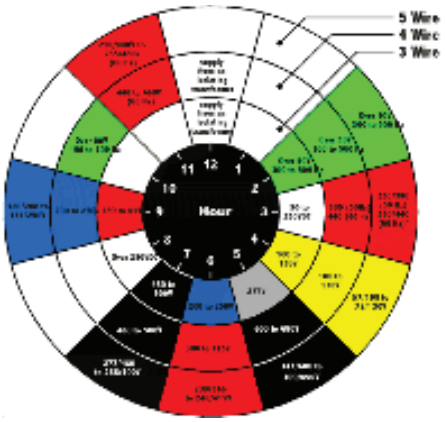
Although these configurations are meant to be non-interchangeable, there are two straight blade configurations – NEMA 5-20 (20A, 125V) and NEMA 6-20 (20A 250V), often called T-Slot receptacles, that allow lower 15A devices to be plugged into higher 20 amperage receptacles and connectors. This is solved with NEMA 5ALT-20R and NEMA 6ALT-20R receptacles that only allow the proper 20A device plug to be connected. This ensures that a 15A device received the proper rated amperage.

Now let's transition to IEC Pin and Sleeve

North American IEC Configurations



International IEC Configurations



devices that are offered in both North American and International Configurations. All IEC 60309-2 Configurations are non-interchangeable among IEC configurations and rely on a ground clock position, (when looking at a receptacle or connector with alignment keyway grove pointed down) which is determined by the numbers of wires and voltage. The devices have specific colors to denote voltage, so from a distance you can determine the voltage used in a particular application. The physical size of the device differs by the number of poles and amperage.

How to read and select the proper IEC Device - There are eight North American IEC 309-2 Clock Positions with ampere ratings from 20-100-Amp and 11 International Configurations ranging from 16-125-Amp. The difference is voltage and ampere ratings. The same rules apply with it comes to poles and wires.

From a safety perspective, some pin and sleeve devices, like Ericson, offer early make and late break features on the contacts. This means the pins sequentially engage when connected. The ground pin first, then neutral, followed by the power poles, which makes then inherently safer. In similar fashion, when disconnected the power poles disengage first then neutral and lastly ground to ensure a safe disconnection and always contact with ground. Most IEC pin and sleeve devices have high-impact nonmetallic external components, adding another level of safety.

Because of their pin and sleeve design, these devices offer greater surface area for the contacts to engage, especially at higher amperages.

When selecting a pin and sleeve product, or replacement, ensure you are dealing with IEC 60309 configurations. There are several legacy pin and sleeve products from various manufacturers that have proprietary configurations and do not intermate with other manufacturers, nor follow the IEC 309 standards. Although perhaps obvious, IEC Pin and Sleeve Devices will not intermate with NEMA style straight or locking devices configurations. ESW

Brian Earl *is VP of Sales and Marketing at Ericson. He has an extensive background in developing and leading a variety of marketing, sales, and technical teams serving customers nationally and internationally. To learn more about Ericson's extensive line of products that comply with NEMA and IEC Configurations go to www.ericson.com.*

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