December 2020/January 2021

Electrical Safety IN THE WORKPLACE

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Everything You Need to Know About Arc Flash Analysis

starting on page 6

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ELECTRICAL SAFETY

LEADERS IN ELECTRICAL SAFETY

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IN EVERY ISSUE

Publisher's Note

Thank you to everyone for the tremendous support of our launch issue in November. We have received a tremendous amount of positive feedback on our newly focused publication. In fact, so many people have reached out to me with additional editorial that I decided to put together this digital edition before our first quarterly issue of 2021.

Thus far, we have received subscription sign-ups from universities, consultants, industrial facilities, power transmission companies, and utilities from here in the U.S. and as far away as Saudi Arabia.

We are forging partnerships (many are a WIP) with associations such as the Electrical Safety Foundation International (ESFI), IEEE IAS Electrical Safety Workshop, NFPA, along with the Partnership for Electrical Safety and their members.

In the coming issues, you will read articles on:

- Safe electrical operating procedures
- How to establish an electrical safe work condition
- Identifying electrical hazards
- Training employees
- NFPA and IEEE standards and codes (i.e. 70E and many more)
- OSHA's lockout-tagout standard and PPE standards
- Preventing electrical fires and explosions that cause serious injuries and fatalities
- National Electrical Safety Month in May
- Asset integrity; predictive and emergency maintenance and repairs; and much more.

Electrical Safety in the Workplace content will constantly reinvigorate the way electrical safety is addressed and report on best practices.

Want to be a part of it? Reach out to me so that we can think strategically about how we can partner together. Also, feel free to sign up for a subscription at **www.electricalsafetypub.com/subscribe**.

I hope you had a safe holiday and a Happy New Year to all!

Randy Green

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By: **Bryan Rupert**, *Contributor*

Arc Flash Analysis:
A Project Overview for Electrical Contractors

The process can be daunting for those contractors who are considering undertaking an arc flash analysis for a client. An arc flash analysis is initiated to evaluate the potential incident energy of an arc flash occurrence. The findings from an arc flash study are used to set arc flash protection boundaries and to help prevent injury by designating the appropriate level of personal protective equipment (PPE) required to interface with a particular electrical circuit or conductor.

Here we'll cover the basics, enough to get you started on assessing your suitability for performing the study. The goal is to provide you with enough basic information to determine where you may need more training and when it makes sense to subcontract parts of the study to more knowledgeable and experienced electrical safety workers, electricians, and/or engineers.

Important Questions for Scoping the Project

As with most any project, an arc flash analysis begins by determining the scope of work. When you work with client companies to define scope, it's important to ask these three questions:

- **Will we be breaking the project down based on equipment voltage levels?** Any facility could potentially have three or four voltage levels, or more, so a project could be scoped based on those levels. For example:
  - 15kV to 600V
  - 600V to 300V
  - Under 300V
- **At what transformer kVA size is engineering no longer required?** According to IEEE 1584 2018 update all transformers of any size need to be considered unless the secondary side of the transformer is 2000 amps short circuit current or below. At that point no additional engineering for any panels or loads beyond that are required to be evaluated and are considered to be less than 1.2 Cal/Cm2.
- **Will the project be rolled out in phases?** If so, where does each phase start and end.

Labels "Points"

When you're ready to estimate the number of points in the study, it's important to clearly define terminology. For our purposes, a single, electrical data-collection point includes feeder wires, protected devices, and the load—in other words, one complete circuit that requires a label. Although point count figures prominently in the estimating of a project's cost and time, keep in mind that actual point count will most likely change by the end of the data collection process; therefore, it's important to keep your estimate flexible to allow for additional points discovered during data collection.

Gather as much point information as possible up front to ensure accurate project estimating. The value of a thorough walkthrough with a knowledgeable person from the client site cannot be overstated. In addition to the walkthrough, the following can also assist in scoping the number of points in an arc flash study:

- Evaluating an existing one-line diagram of the facility.
- Reviewing an asset list and/or floor plans that include electrical distribution.
- Studying diagrams or lists for a building with a similar footprint.
- Researching historical electrical maintenance reports.
- Reviewing existing photos of electrical distribution.

Data Collection

Data collection refers to the start of the field work portion of the arc flash analysis process. It involves locating and identifying electrical data collection points by a qualified data collection worker. This person should be familiar with the design and construction of the electrical equipment in the facility and knowledgeable about

the level of risk associated with the equipment and the appropriate PPE required to mitigate that risk. A rule of thumb in the industry stipulates that a qualified worker should be able to collect at least 35 points a day in an "average facility"—roughly four points an hour. Recognize, though, that it is more complicated to collect data and rate arc flash potential in facilities like hospitals and other vital installations that require maintenance staff to service equipment without powering it down.

Following are suggestions for implementing a successful data collection effort:

- Use available tools for performing data collection. Examples include:
  - Templates or spreadsheets that are available online or on paper.
  - Software tools designed for data collection.
- Log all point data in a neat and uniform manner.
- Collect photos of each point, including existing nameplate information from the device and breaker settings. Although photos are not required, they are considered a best practice in the industry. Photos are especially useful for two reasons:
  - Engineers can more readily evaluate the state of the equipment.
  - Downstream label installation and asset management becomes much easier.
- Create a field one-line diagram or use an area of your template or spreadsheet to establish the relationship between sections of equipment.

Engineering Evaluation and Interpretation

The next step is to work with a licensed engineer for evaluating and interpreting the collected data. It's important that contractors engage experienced and knowledgeable engineers trained in assessing power systems. For this reason, many electrical contractors subcontract this work to appropriate sources.

The licensed engineer is responsible for performing the necessary incident energy calculations and establishing whether each circuit meets the national electric code. These incident energy calculations will be used to determine arc flash boundaries and PPE required at each point location. In my experience, approximately 90 percent of code violations are due to protective devices (i.e., fuses or breakers) being mismatched to the associated wire. Other benefits of the engineering portion of the study include the opportunity to evaluate the equipment's ability to contain a short circuit and finding hints that the system may have potential coordination issues. These are just a few examples that illustrate why the engineering calculations and findings are crucial to a successful arc flash analysis.

Besides interpreting the data and creating the incident energy calculations, the following also result from engineering collaboration:

- Arc flash one-line diagrams are created, usually with the help of an arc-flash evaluation software program.
- Electricians review the arc flash one-line diagrams for accuracy
- Client representatives review the one-line diagrams for correct nomenclature. (According to code, every point is required to be named.)

Once the client has signed off on the engineering review, an analysis report containing findings and recommendations can be created and you're ready to print labels for installation. However, an experienced contractor would instead use this time to perform mitigation or coordination, as these activities will most definitely impact the label outcome.

Mitigation or Coordination

Working with the engineering reports, an experienced contractor, typically with the help of engineering, reviews the incident energy levels to determine if they are acceptable and typical for each device in the system. Depending on the facility type and the purpose of the device, you may arrive at a decision to mitigate the findings—in other words, look for ways to reduce incident energy of an arc flash and thereby increase safety. Or you may choose to completely focus on coordination—protecting wires and devices without regard for life safety.

When mitigating, you might find opportunities to de-energize, if it makes sense, or increase working distance and/or ramp up PPE. Any of these changes will impact label content, thus the reason for delaying label printing and installation until after mitigation.

Label Installation

Once labels are printed, it's important that they be installed in the correct locations; therefore, the task needs to be assigned to someone familiar with the facility and the equipment. It's here, during label installation, and also during asset management, that the contractor and the client realize the full benefit of the time taken earlier to photograph and catalog each of the points. Following are standard guidelines and best practices for label installation. (For

complete information, refer to the NFPA 70E 2015 electrical safety standard.)

- Affix each label to the appropriate device.
- Place each label so a qualified technician working on the device can easily read the label.
- In addition to the required label information such as date, voltage, highest hazard risk category, etc., as a best practice, you should also ensure that each label contains the following:
  - A name that matches the nomenclature from the arc flash one-line diagram.
  - Glove class.
  - Approach boundary indicators.
  - The name of the upstream protective device.

Training

All of the work that went into collecting, cataloging, mitigating, and labeling points is only useful if your client understands the importance of training qualified workers to read the labels and implement the necessary boundary information and PPE guidelines. Therefore, any thorough arc flash analysis process should include a training program for qualified workers. Per the NFPA 70E 2021 standard, this training must be repeated in intervals not to exceed three years. The program should educate attendees on the guidelines for what constitutes a "qualified" worker and to what extent a worker is considered "qualified."

- The requirements for being considered a qualified worker:
  - Worker recognizes the degree and extent of an electrical hazard.
  - Worker understands the PPE requirements for performing a task safely.
  - Worker is capable of implementing job planning and preparation steps for minimizing risk.
- Who is not a qualified worker:
  - Someone who does not have the skills and knowledge to operate the electrical equipment.
  - Someone who has not had the training to r ecognize hazards associated with a particular task or equipment.

Additionally, the client needs to understand the importance of PPE in the safety equation. To assist in that understanding, experienced contractors should collaborate with their clients to determine what level of PPE should be provided to a client's qualified workers. PPE decisions should take the following into consideration, within reason:

- The budget limitations of the safety program.
- The incident energy levels contained in the resulting arc flash report.
- The skill levels of the workers involved.

PPE technology changes frequently, so it's also important for contractors to stay up-to-date on the latest offerings with regard to new products, materials, and fit and to share that information with clients.

When a competent program is handled well—from initial data collection through employee training—the contractor and the client can know they've done their best to minimize the risks associated with arc flash. For more information or answers to your questions, feel free to contact us at Facility Results. ESW

Bryan Rupert is co-founder and lead consultant at Facility Results, a Plymouth, MI, company that designs and markets an extensive collection of electrical reliability and safety solutions, including FlashTrack™, the company's award-winning, flagship software package for performing arc flash analyses. (www.FacilityResults.com)

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By: **Bryan Rupert**, *Contributor*

Add a Lucrative Revenue Stream by Offering Arc Flash Services

An arc flash analysis (AFA) is mostly performed by electricians and professional electrical engineers. The first phase of an AFA must be performed by a qualified worker, most appropriately a licensed electrician. Most companies look to outside contractors to provide AFA services in general, including the data collection. You as an electrical contractor, may be considering branching out into this growing and profitable field. It is here you can read about how to propose a project scope, how to price the project, and how to discover other opportunities that result from data collection.

Preparing the Project Scope

It's important to do an accurate job defining the scope of a data collection project before you attempt to quote the work. When defining the scope, you have the opportunity to approach the data collection portion of a client's AFA request in phases, which can help you manage your work schedule and help your clients feel more in control of their budgets. This approach will differentiate you from other contractors who only consider quoting a complete site. You can define the scope of the project based on different criteria. Here are a few logical criteria to use as a basis for defining scope:

- **Voltage levels:** Depending on the number of voltage levels in a facility, you may want to define the project parameters based on voltage class. For example, Phase I might span from 15kV down to 600V class equipment, Phase 2 from 600V to 300V, and Phase 3 for everything under 300V.
- **Equipment type:** Sometimes it makes sense to define your scope based on equipment type. An example of this might be defining a phase that starts at the utility transformer and goes up to the busway or 800 amp distribution panels. The next phase might be from the busway to the floor equipment it feeds, or from the 800 amp panel to down to 200 amp loads.
- **Number of points:** If your pricing is point-based, a client may simply choose to scope the project based on the number of label/ points that will work with their budget at the time.

Pricing the Project

The two most common pricing models for arch flash projects are based on time and materials or cost-per-point. There's a tendency, especially if you're new to this type of project, to want to price it the "safe" way—based on time and materials. While time and materials presents the least risk to you as a contractor, it will be a hard sell to your client. Clients need cost parameters; they seldom will approve any job carte blanche. In addition, contractors familiar with arc flash analysis know from experience that the time and materials model can limit profitability. Consider this example (using basic figures for simplicity):

	HOURLY RATE	PER-POINT RATE
Rate	$100 per hour	$25 per point
Avg points collected	6 per hour	6 per hour
Total for 8-hour day	$800	$1,200

The rule of thumb is that an experienced qualified worker can collect, on average, four to six points an hour—35 points a day at an average facility. Consider that the more familiar you become with performing data collection, the faster you'll get. Using a per-point model, you'll stand to come out ahead as you become faster at data collection.

As you set your rate for either type of pricing, remember to account for overhead costs. The most basic tools required for AFA data collection are pen and paper. Realistically though, you'll want to have a spreadsheet tool at a minimum. If you want to be more competitive,

consider introducing into your process a data collection software tool, which was designed to assist electricians in collecting the vital information needed for an arc flash analysis, short-circuit calculation, or coordination study.

In the case of setting per-point pricing, since you won't be billing an hourly rate, remember to account for the cost of having an electrician on-site, including travel time, set-up time, and the planning time that went into the project.

When estimating your time for the project, remember to set an expectation with your client that the project size can change. When you visit a site in preparation for quoting a job, you don't always get the complete picture. During a facility tour, you're typically not going to open enclosures to see what's inside. The fact is, points exist within points. For example, a power distribution panel or motor control center (MCC) may have a protective main, which would be two points. Or you're quoting based on an "as-built" one-line for the facility. (Always keep in mind that as-built one-lines never represent reality.) Either way, the number of points can often turn out to be higher than you originally thought. Therefore, it's always a good idea to make an allowance for providing a Project Change Notice later to account for additional points not contained in the original estimate.

Receipt of Order

When branching out into this growing, lucrative market, it's likely you'll need to spend considerable time planting seeds for new business before you get your first order. You may be pleasantly surprised to find an occasional client who has budgeted funds "shovel ready." But it's more likely that, regardless of whether the project scope is 80 points or 800 points or more, you may have to wait months or even years to hear back that an order has been approved. When you do hear back, especially when a year or more has passed, be sure to review your original estimate with the client to account for any site changes. You'll also want to account for any price increases that may affect your original estimate.

Data Collection as the Bridge to New Opportunities

Don't forget about other opportunities tied to the arc flash study data gathering. As an electrician performing data collection, you have a unique perspective for identifying additional opportunities to assist your client with electrical needs.

Site Training: When it comes to electrical safety, qualified workers are required to be trained. OSHA and the NFPA 70E standard stipulate that businesses must have a written safety program and training shall be provided not to exceed every three years. Even unqualified workers are required to be trained on electrical hazard awareness and symbol recognition. As an electrical contractor familiar with your client's electrical system, with the right training, you can help to train those workers. The best safety training programs are site-specific and focus on practical application for the qualified worker. If you intend to branch out into electrical safety site training, it is not enough to sit and read the training standards to your students. Design the training program to be useful and effective. Done correctly, the training should be able to be accomplished in four hours or less. Training of qualified workers should include, but not be limited to:

- Understanding how to interpret label data
- Inspecting and caring for personal protective equipment (PPE)
- Field inspecting and testing gloves—the correct processes and intervals—and dielectric glove testing requirements
- Evaluating risk associated with the tasks at hand

Code Violations: You're bound to come across code violations during data collection. It's extremely rare to complete data collection without identifying any electrical code violations. In fact, in October 2014, OSHA cited electrical-related violations in three of its TOP TEN Most Frequently Cited Violations.[1] Specifically, these included Lockout/tagout (#6), Electrical: wiring (#8), and Electrical: system design(#10). Not surprisingly, number two on the OSHA list was Hazard communication. All of these point to arc flash data collection as an opportunity to identify future opportunities for performing repairs to ensure worker safety and the integrity of the electrical system.

Mitigation/Coordination: As an electrical contractor, mitigation and

1 "Top Ten Most Frequently Cited Standards," OSHA, October 28, 2014. https://www.osha.gov/Top_Ten_Standards.html

coordination can also open doors to new business. Early in the arc flash study, determine if your clients are more interested in equipment reliability (coordination) or life safety and equipment protection (mitigation). Examples of sites that focus on coordination are data centers, research and development labs, and defense contractors. Examples of sites more interested in mitigation are manufacturing facilities and office buildings. Ensuring your client sites conform to their needs—whether coordination or mitigation—can lead to additional income opportunities.

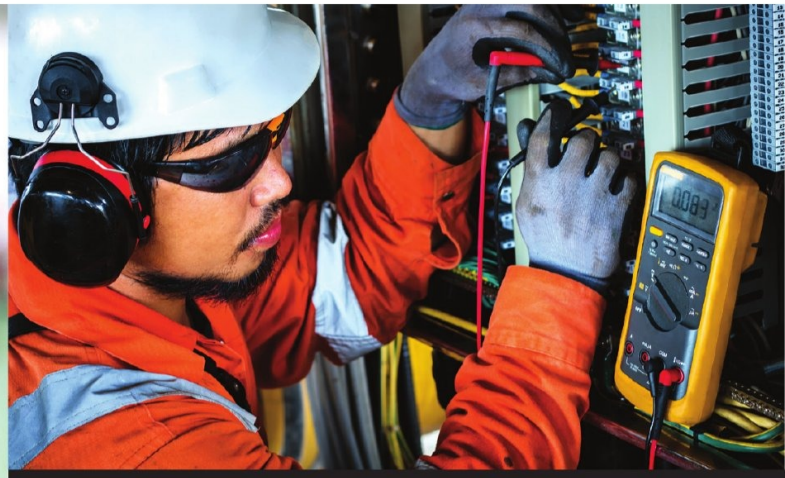
Managing Change: Considering that every facility is dynamic, updates will always be necessary. The NFPA 70E standard stipulates that an arc flash analysis requires periodic review and updating during a timeframe that is not to exceed five years, or more frequently if the system is modified. Use this as an opportunity to set up a regular schedule with your client to update their one-line diagrams and labeling. It's not cost effective to be called out every time the client reports a single change. Instead set a reasonable threshold for visiting after a recognized minimum number of changes. Based on the rule of thumb that a qualified worker can collect at least 35 points a day, consider re-visiting after 15 or 30 point changes, thus ensuring at least one-half to one full day's work. In a perfect world, your clients would contact you when they've added or subtracted components. But the reality is, you'll most likely need to contact them to remind them of the need to update their study.

Maintenance: The NFPA 70E and the NFPA 70B standards stipulate that maintenance is required for equipment directly associated with employee safety. Performing arc flash studies also leads to maintenance opportunities, especially for infrared and ultrasonic testing. As a field electrician, you'll be close enough to identify some loose connections or see obvious signs of electrical tracking. Any anomalies should be recorded and documented during the data collection phase. These visual observations should also be reported in the final Arc Flash Analysis report. Later, you may have the opportunity to, at a minimum, return and do a thorough pass using infrared testing.

One of the most critical parts of the arc flash analysis process is the data collection. When it's done well, not only does it provide your client with OSHA compliance, it also has the potential to protect your client from unnecessary risk. In addition, doing the arc flash data collection, the contractor can find additional work through non code compliant installations. ESW

Bryan Rupert is co-founder and lead consultant at Facility Results, a Plymouth, MI, company that designs and markets an extensive collection of electrical reliability and safety solutions, including FlashTrack™, the company's award-winning, flagship software package for performing arc flash analyses. (www.FacilityResults.com)

Electrical Safety IN THE WORKPLACE



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☐ Ladders Lifts & Platforms
☐ Lockout/Tagout
☐ Lighting & Controls
☐ Low/Medium Voltage
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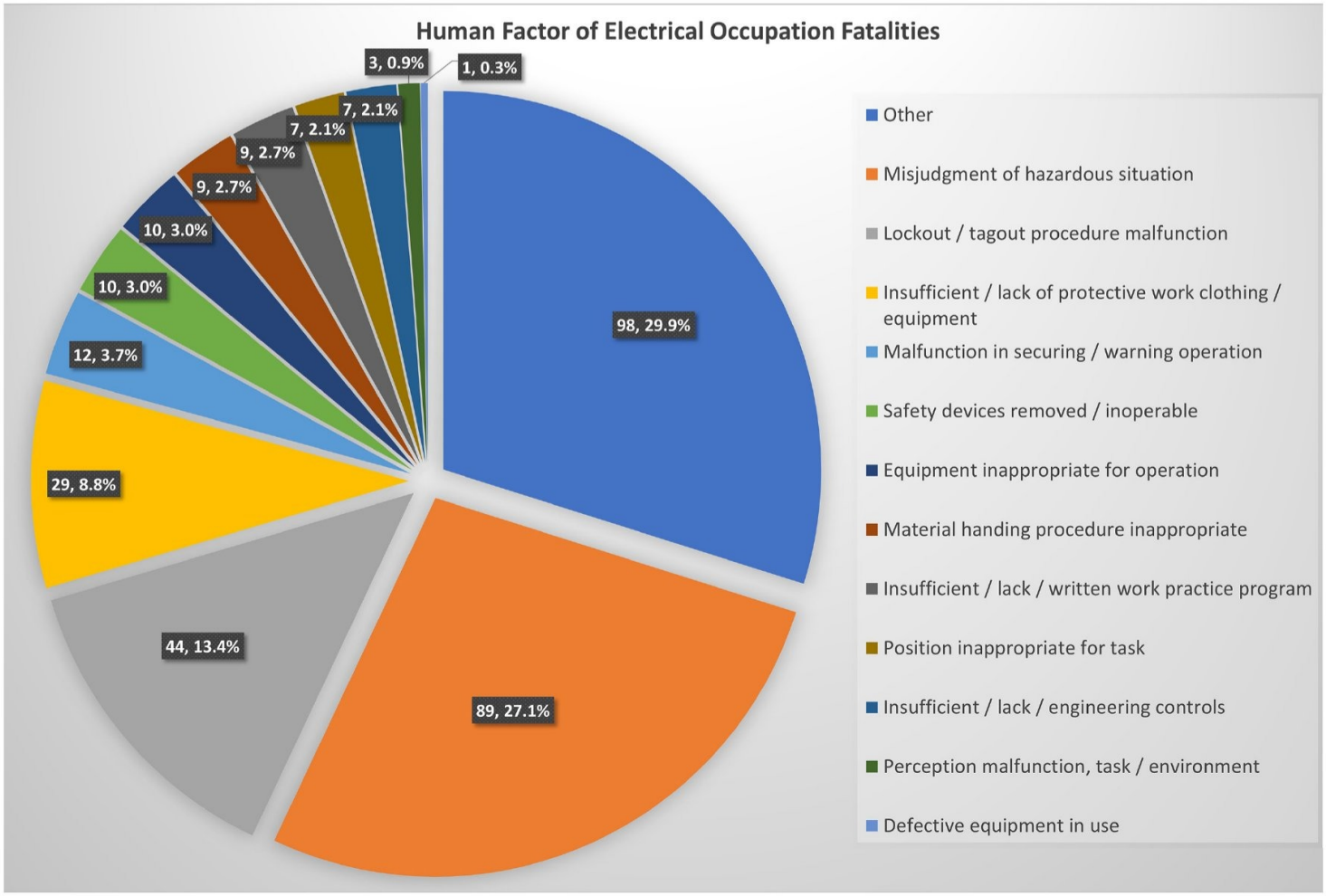
By: **Brianne Deerwester**, *Contributor*

Lockout/Tagout Compliance Saves Lives

Each day, nearly three million professionals participate in work activities where lockout/tagout procedures should be used. Unfortunately, too many workers put themselves unnecessarily at risk by working energized or neglecting to follow their company's lockout/tagout procedures. These procedures safeguard workers from the unexpected energization, or startup, of machinery and equipment. They can also prevent the release of hazardous energy during service or maintenance activities. Always de-energizing and following established lockout/tagout procedures saves lives. Compliance with OSHA's lockout/tagout procedure prevents an estimated 120 fatalities and 50,000 injuries each year. In 2019, control of hazardous energy (lockout/tagout) was the fourth most frequently cited OSHA standard.

The Electrical Safety Foundation International (ESFI) publishes fatal and nonfatal U.S. occupational electrical injury information in tabular and graphical form on esfi.org each year. The data is calculated using the U.S. Bureau of Labor Statistics' (BLS) Census of Fatal Occupational Injuries (CFOI) and Survey of Occupational Injuries (SOII). The data in these reports cover electrical accidents, including the total number of electrical injuries and fatalities, the industries and occupations in which they occurred, and the rates of electrical injury and fatality for selected industries. ESFI compiles the data to track electrical injury trends and to identify occupations and industries where electrical safety training can be applied to reduce the number of occupational electrical injuries.

Failure to comply with the lockout/tagout standard is listed as one of OSHA's top 10 most frequently cited standards year after year. Workers injured on the job from exposure to hazardous energy lose an average of 24 days of work to recuperation. Looking at the 328 electrical occupation fatalities that occurred between 2011 and 2019, lockout/tagout procedure malfunction was the cause in 44 cases, or 13.4%. This was the third leading cause of electrical occupation fatalities. The first leading cause was listed as other (98 cases or 29.9%), while the second cause was misjudgment of a hazardous situation (89 cases or 27.1%). Insufficient/lack of protective work clothing/equipment (29 cases or 8.8%), malfunction in securing/warning operation (12 cases or 3.7%), safety devices removed/inoperable (10 cases or 3%), equipment



inappropriate for operation (10 cases or 3%), material handing procedure inappropriate (nine cases or 2.7%), insufficient/lack/written work practice program (nine cases or 2.7%), position inappropriate for task (seven cases or 2.1%), insufficient/lack/engineering controls (seven cases or 2.1%), perception malfunction, task/environment (three cases or 0.9% of cases), and defective equipment in use (one case or 0.3%) accounted for the source of the remaining fatalities.

The following steps (https://www.esfi.org/resource/lock-out-tagout-your-life-depends-on-it-544) should be implemented in your company's lockout/tagout procedure. First, notify all employees about the required lockout. Begin by shutting down equipment using the normal stopping procedure. Locate and isolate equipment from all energy sources and release any stored energy. Next, lockout all switches and controls with assigned locks and tags. After ensuring that no personnel are exposed, operate the normal operating controls to make sure the equipment won't operate. Return equipment to "off" state after the test and perform servicing. Then, remove the lockout device. Once work is completed, notify all employees. Working on energized equipment increases your risk of injury and death. The number one way to prevent these incidents is to de-energize the equipment you're working on. Be proactive about de-energizing equipment and taking steps to ensure that your work environment remains safe.

Teaching workers how and why to follow proper lockout/tagout procedures can help to avoid unnecessary risk and reduce the number of workplace injuries and fatalities. A written version of lockout/tagout procedures should always been available for workers to reference when needed. A written plan is also needed for complex lockout/tagout. A qualified worker should be appointed to handle the procedure. It is imperative that they account for all workers and energy sources. Complex logout/tagout is used when there are multiple aspects involved, such as different locations, crews, or energy sources. These simple steps require extra planning but will take less time than the potential downtime and days away from work an accident could cause. The greatest value of any workplace is the people, so it is imperative to keep them safe by establishing safety procedures, including lockout/tagout, and a safety program that provides proper electrical training. For more information on how to implement safe practices on the jobsite and to share ESFI's materials throughout your workplace, visit esfi.org. ESW

Brianne Deerwester is the Communications Coordinator for the Electrical Safety Foundation International (www.efsi.org.com).

By: **Andrew Cochran**, *Contributor*

Effective Electrical Safety Comes Down to Two Factors: Engaged Leadership and Technical Awareness

Continuous improvement is a way of life for any business and is accepted as a standard approach in improving quality, productivity, and processes. At the core of continuous improvement is defining root causes, planning, and executing preventative action to eliminate the potential issue, and deploying technology and practices that minimize the impact of any issue or hazard.

This approach to continuous improvement can be extended to electrical safety and is sorely needed.

Ask any executive, operations manager, or health and safety professional and the very first priority in dealing with a potentially negative issue is to prevent the issue from occurring whenever possible. The second priority is to minimize the impact should the negative event occur.

This structured approach is consistent with the Hierarchy of Control and is consistent with the updated language in NFPA 70E Annex 0 General Design Requirements 0.2.2:

Design option decision should facilitate the ability to eliminate hazards or reduce risk by doing the following:

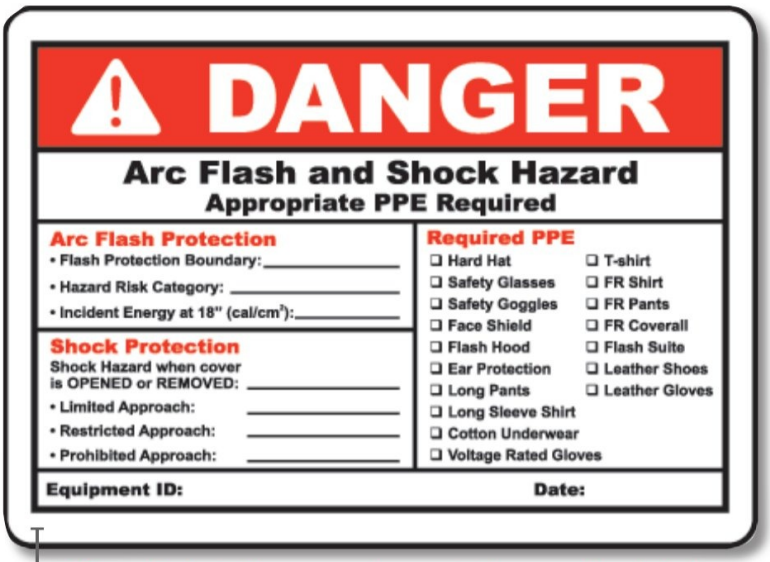
1. Reducing the likelihood of exposure
2. Reducing the magnitude, or severity of exposure
3. Enabling achievement of an electrically safe work condition

This is where the need for engaged leadership is required. We need to be asking the fundamental question, "have we as an organization taken steps to reduce the likelihood of exposure and/or reduce the magnitude of exposure, rather, or have we settled for protection and awareness only?"

Many industrial companies have taken the approach of conducting an arc flash study, or some form of electrical risk assessment, posting the resultant warning labels, purchasing PPE, and then stopped. The result is warning labels informing of a dangerous situation, but no proactive measures to reduce the likelihood of exposure or to mitigate the magnitude of the hazard. Engaged leadership can only be effective if there is technical awareness within the organization to answer the question: "what can we do to lower our risk and lower the hazard level?"

Consultants, facility managers, and maintenance personnel (the very people engaged leadership would turn to and ask the question) were asked two questions related to arc flash and electrical safety:

- What in your opinion is the leading cause of arc flash incidences?
  - o Three phase faults
  - o Ground faults
  - o In-line faults
  - o Phase to phase faults



Many industrial companies post the warning labels, informing of a dangerous situation, but take no proactive measures to reduce the likelihood of exposure or to mitigate the magnitude of the hazard.

- What is the best means to minimize the arc flash hazard?
  - o High-Resistance Grounding
  - o Optical Detection
  - o Labels and warnings
  - o PPE

The results are a cause for concern at several levels; only 50% of respondents correctly identified that the majority of arc flash incidents start as ground faults and yet 268 of these chose labels of PPE as the best means to minimize the arc flash hazard. Posting warnings, conducting awareness training, and purchasing and issuing PPE does not in any way reduce the likelihood of an arc flash event, nor does it reduce the magnitude of the arc flash. For those professing that PPE does reduce the severity of exposure, let's pause and consider what it means to wear ARC-rated clothing – there is a 50% probability of receiving second-degree burns over 50% of your body; surely, we can't accept this is safe.

This is why engaged leadership is not enough; there is a need for technical awareness also to achieve an effective electrical safety program and a safe electrical workplace.

When designing an electrical grounding system for an industrial operation for voltages of 1000 volts and below, there are three basic choices – ungrounded, solidly grounded, or resistance grounded – a technical decision.

Absent ground faults, any of the three options are reliable and safe, but ground faults are a reality in any electrical system and so the question becomes—does the

grounding system choice affect the likelihood of experiencing an arc flash incident?

Control the Likelihood of Exposure

The first and obvious step is to de-energize the electric circuit before conducting any work whenever practical. If this isn't practical or safe, then consider options that reduce the likelihood of an arc flash event occurring.

Again, referring to NFPA 70E, Annex 0 clause, "A great majority of electrical faults are of the phase-to-ground type. High-resistance grounding will insert an impedance in the ground return path and below (at 5kV nominal or below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level."

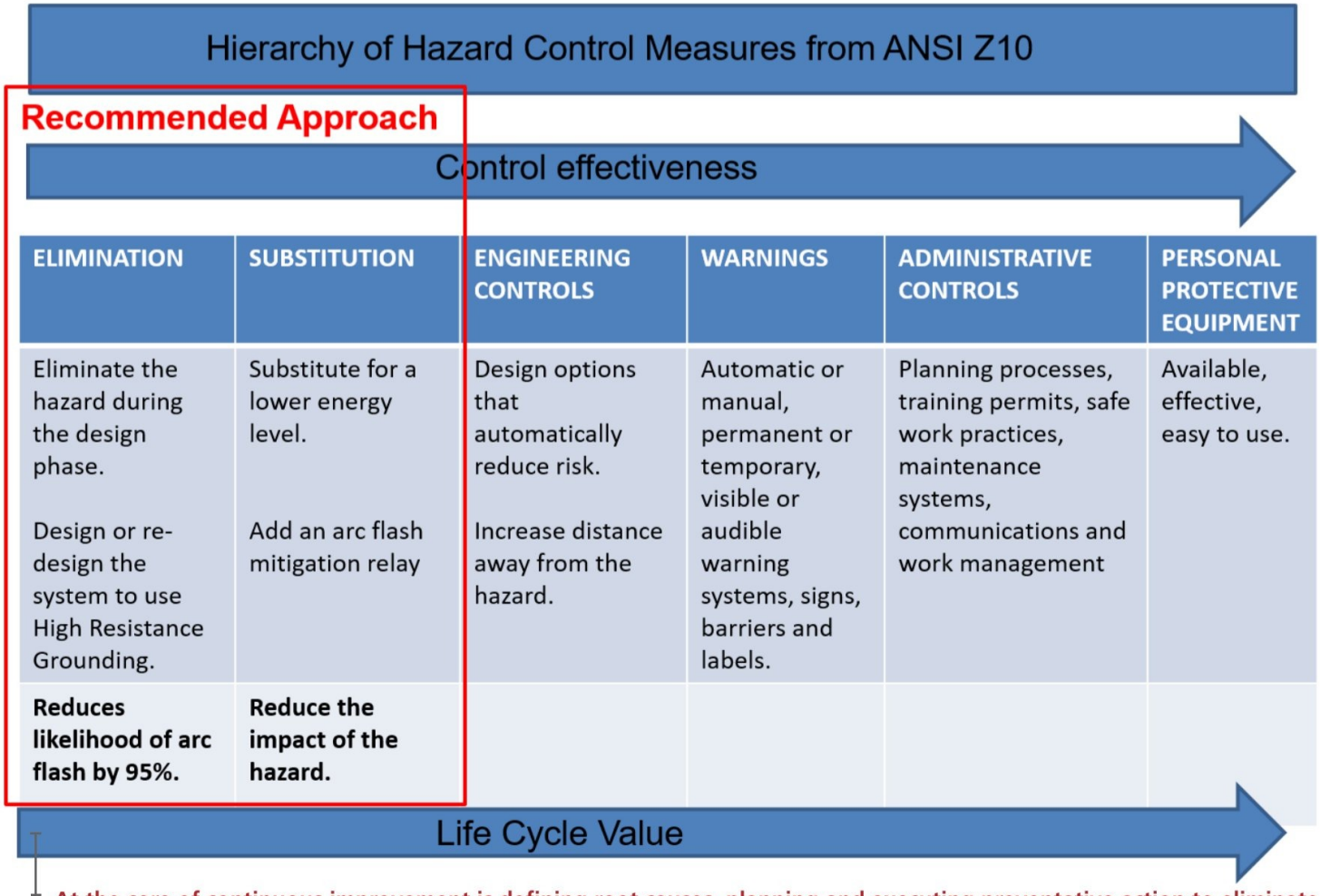
This is consistent with statements in the Industrial Power System Grounding Design Handbook which states that 95% of all electrical faults are phase to ground faults and IEEE141-1993 Recommended Practice for Electric Power Distribution for Industrial Plants 7.2.2 which states "there is no arc flash hazard (on HRG systems) as there is with solidly grounded systems, since the current is limited to approximately 5 amps."

In FM Global Standard 5-18 Protection of Electrical Equipment Single Phase and Other Related Faults it states, "Sustained arcing faults in low-voltage apparatus are often initiated by a single-phase fault to ground which results in extensive damage to switchgear and motor control centers."

If we already understand that most arcing faults start as single-phase to-ground faults, (whether the specifics are 95% or the great majority) and that by employing High-Resistance Grounding (a technology that has been around for 50 years and used in all manner of industries, from petro-chemical to food processing, automotive, paper manufacturing, and data centers), we can reduce the exposure to the hazard significantly. The question then needs to be asked, "Why is this not the standard practice for grounding industrial facilities?"

HRG as a technology is recommended by IEEE, it is recognized by NFPA 70E, it is promoted by FM Global, and yet it is still not the default option when making the grounding decision for industrial facilities. One reasoning may simply be lack of technical awareness.

Of course, High-Resistance Grounding does not protect against phase-to-phase faults nor does it lower the incident energy calculation and therefore additional control steps must be taken to ensure an electrically safe workplace.



At the core of continuous improvement is defining root causes, planning and executing preventative action to eliminate the potential issue, and deploying technology and practices that minimize the impact of any issue or hazard.

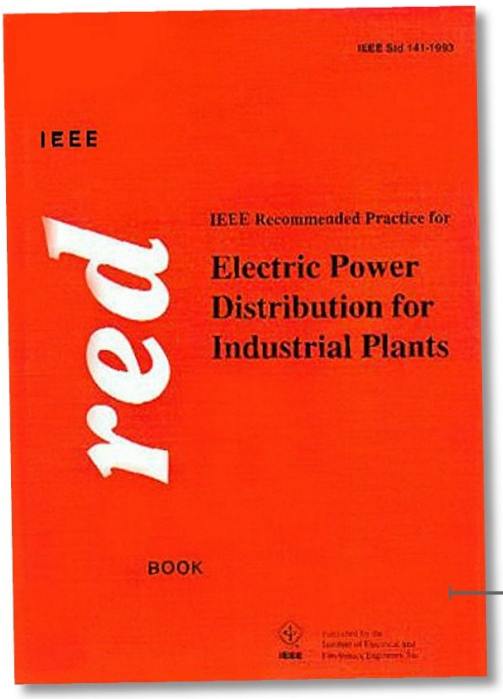
Reduce the Magnitude of Exposure

Again, referring to NFPA 70E, Annex 0 clause states "Arc flash relay. An arc flash relay typically uses light sensors to detect the light produced by an arc flash event. Once a certain level of light is detected, the relay will issue a trip signal to an upstream overcurrent device."

An arc is developed in milliseconds and leads to the discharge of enormous amounts of energy. The energy discharged in the arc is directly proportional to the square of the short circuit current and the time the arc takes to develop, i.e., energy = I2t.

The damage resulting from the arc depends on the arcing current and time. Of these two factors, time is the most easily controlled and managed. Rules of thumb for different arc burning times are:

- 35ms or less – no significant damage to persons or switchgear which can often be returned to use after checking for insulation resistance.
- 100ms – small damage to switchgear that requires cleaning and possibly some minor repair. Personnel could be at risk of injuries.
- 500ms – catastrophic damage to equipment and personnel are likely to suffer serious injuries.



The goal of arc mitigation technology is to protect personnel and property. To effectively accomplish this, we must first detect the arc, and then cut the flow of current to the arc in as short a time as possible. As noted above, the target is to achieve a total reaction time of 100ms or less from detection of the arc to isolation of the circuit.

Arcs produce light at intensity levels that exceed 20,000 lux. This can be detected through special arc detection optical sensors connected to a relay system that has a typical operating time under 1ms and is the fastest arc flash detection technology currently available. The operating time is independent of the fault current magnitude since any current detector elements are used only to supervise the optical system.

With optical arc protection technology installed, the relay operating time is essentially negligible compared to the circuit breaker operating time. The cost is also fairly low since current transformers are only needed on the main breakers. If we sum up the circuit breaker operating time and the optical arc detection time, we are well below the goal of 100ms (regardless of the age and speed of the circuit breaker) and have mitigated the damage to a lower and safer level.

Simply changing from standard coordination and instantaneous settings on the relay (suggested by some consultants as sufficient) to a protection system which uses optical arc detection that incident energy levels are reduced substantially.

A workplace where the likelihood of an arc flash is significantly lower, where the impact of an arc flash can be minimized to very low levels is possible today – we just need engaged leadership and technical awareness.

The IEEE141-1993 Recommended Practice for Electric Power Distribution for Industrial Plants 7.2.2 states "there is no arc flash hazard (on HRG systems) as there is with solidly grounded systems, since the current is limited to approximately 5 amps."

Unintended Benefit of HRG Technology:

One industrial client who made the conversion from solidly grounded to HRG technology as a means of reducing the arc flash risk found the unintended but welcomed benefit of lower maintenance costs related to motor repair.

In fact, the savings in motor repair costs provided payback for the HRG system in 24 months.

This leading company, through engaged leadership and with technical awareness, lowered its risk of an arc flash from occurring and lowered operational costs at the same time.

What is stopping you from achieving the same results, engaged leadership or technical awareness? ESW

Andrew Cochran is President at I-Gard Corporation, an industry leader in workplace electrical safety, with a focus on protection from ground faults and arc flash. Cochran joined the company in 1997 having previously held operational roles in companies such as Polaroid, ITT Automotive, and Stanley. At I-Gard he is responsible for setting the company's strategic direction and focuses on driving progress in ensuring workplace electrical safety issues are addressed through technology and awareness. (https://i-gard.com)

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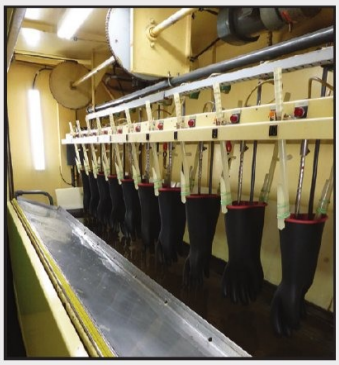
The Voltgard® Test Lab a division of Saf-T-Gard International, Inc.

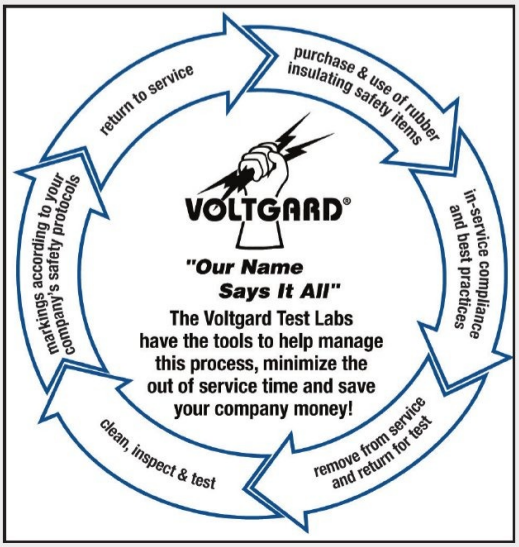
About Us

Located in Northbrook, Illinois, Saf-T-Gard International, Inc. is a privately-held family-owned and operated manufacturer, distributor, importer, exporter and global supplier of personal protective equipment, electrical safety, facility safety and first aid. Today, Saf-T-Gard carries on the tradition that was started more than 80 years ago: Bringing customers the products, training and service they need to keep employees safe in the workplace.

The Voltgard® Test Lab is a division of Saf-T-Gard International, Inc., a family-owned and operated manufacturer, distributor, importer, exporter and global supplier of personal protective equipment, electrical safety, facility safety and first aid. Based in suburban Chicago, Saf-T-Gard has been bringing workers home safely since 1936. The Voltgard® project was launched in 1983 as a small test lab with the mission to develop the electrical testing and utility industry business by providing the testing of rubber insulating products to complement the sales of new products. Today, it is the largest, independent, NAIL4PET-accredited test lab for rubber insulating products in the United States and provides full-service testing and recertification of rubber gloves, sleeves, blankets, line hose, covers, dielectric footwear, jumper cables, grounding sets, plastic guards, hot sticks, matting, hoods and insulating hand tools – all to applicable OSHA standards.



The Voltgard® Test Lab acts as an off-site lab for numerous utilities, telecom companies, contractors, municipalities and industrial facilities nationwide. The Voltgard® division of Saf-T-Gard is dedicated to serving industries where worker safety and protection from electrical current are critically important and has developed its own proprietary Voltgard® brand of award-winning electrical safety products, including the Voltgard® V-GRIPS® Leather Protector Gloves and the Voltgard® Telescopic Insulated Rescue Body Hook in addition to offering a full line of electrical safety products ranging from rubber insulating goods to arc flash safety clothing and kits to grounding equipment and so much more! Saf-T-Gard also developed The Original Rubber Goods Change-Out Program®, the industry's first, start-to-finish solution that monitors, tracks and manages the rubber goods' in-service use and testing intervals to minimize out-of-service time and ensure tested materials are received within compliance deadlines so that workers can remain safe and productive. Additionally, Saf-T-Gard has one of the largest new rubber goods inventories in the world and can immediately replace any goods not meeting applicable standards. Furthermore, the Saf-T-Gard and Voltgard® team has more than 100 combined years of safety experience that includes ASTM Voting Members, OSHA 30-hour trained safety professionals, Qualified Safety Sales Professionals (QSSP) and NFPA 70E trained safety professionals. The expertise of our team can be an extension of your team when you partner with Saf-T-Gard on your company's safety program. Our comprehensive electrical safety program delivers proven time and cost savings for our customers in nearly every industry, and we can do the same for you! No one else offers the Voltgard® level of service!



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Did you know that an investment in safety performance is also an investment in operational performance? Research shows that best-in-class organizations rely on their safety systems to both prevent costly injuries and improve productivity. At SEAM Group, we have seen these results firsthand. Manufacturing facilities, distribution operations, retailers, hotels and hospitals, across the globe have leveraged our integrated approach to energized asset optimization to help save lives, prevent injury, and bolster the bottom line. From improvements in preventive failure finding and turnaround time – to up to a 40% reduction in asset downtime – our clients routinely demonstrate that safer organizations run better.

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By building strategies to fully integrate asset safety, reliability, and maintenance efforts, organizations can begin to direct investments toward the most critical risks to human safety and operational performance and better position themselves for long-term growth. At SEAM Group our integrated approach to energized asset optimization has helped organizations in all 50 states and more than 80 countries globally connect the dots between safety, reliability, and maintenance.

Our comprehensive services include consulting and training, inspection and assessment of energized assets, and asset installation and repair. All of our services are supported by certified professionals and powered by our ViewPoint platform for real-time visibility to asset status and program performance. With offices in North America, Europe, and Asia, we can help organizations across the globe identify gaps in asset management and implement solutions for long-term safety and performance outcomes.

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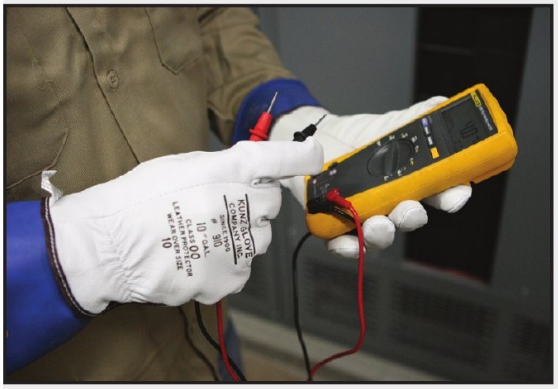

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Enespro PPE is an exciting, new brand of USA-made electrical personal protective equipment (PPE) featuring advancements in performance, comfort and functionality. Enespro PPE conducted extensive research with electricians and electrical safety professionals to gain critical insights required to achieve breakthrough improvements in electrical safety PPE. Coupled with extensive industry experience, Enespro now offers a complete line of arc flash kits, arc flash suits, rubber voltage gloves and glove kits, hood & face shields, and PPE storage bags.

We believe that true leadership is about being the first to see a problem and take the initiative to solve it. By this measure, Enespro is the emerging leader in electrical PPE. We have conducted extensive research with electricians and safety leaders to discover their pain points, challenges and priorities regarding electrical PPE. We've also invested in breakthrough innovation that solves those pain points and challenges.

TAKING THE LEAD BY TAKING ACTION

To us, leadership is not about sales numbers or company size. Launched just three years ago, Enespro may not be the biggest brand in electrical PPE, but we are also not novices. Our executive team has been involved in the electrical safety industry for decades, and we already have a full line of USA-made arc flash PPE that is preferred by hundreds of companies.

LISTENING FIRST TO MAKE A DIFFERENCE

Enespro PPE was founded to make a difference in electrician safety. That's why we actually ask people in the industry what's working for them and what's not. It's also why we listen to gain a deeper understanding of issues to help make electrical workers safer — and why our PPE challenges the status quo with design and details that focus on removing any barriers to use.

INVESTING IN INNOVATION

Enespro will continue to invest in ongoing research, so we can understand the perspectives of electricians and safety professionals on problems with current electrical PPE. It's just one more way we're committed to investing in meaningful innovation, so we can solve problems, improve the PPE experience and make electrical workers safer.

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Lakeland Industries Protective Garments

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At Lakeland Industries, our number one priority is creating protective garments that protect your people from fire, hazardous chemicals, and diseases, throughout the world.

Lakeland Industries' mission is to create and manufacture a wide variety of technologically advanced protective clothing that saves lives and protects workers.

Producing protective garments for the electrical safety industry starts with a thorough understanding of the challenges and dangers workers face and creating garments designed to enhance performance and safety.

Lakeland's innovative technology and design features set the highest standards in the industry. With inherently moisture-wicking garments for all weather conditions, you can have confidence that your team will stay comfortable, safe, and protected when you choose Lakeland.

Lakeland's high-performance FR/AR layering system features permanent moisture-wicking fibers in every layer: base layers, mid layers, and outer layers. Lakeland's inherently FR fabric offers dual hazard protection for flash fire and arc flash, which means workers are protected as worksite conditions change. Maximize performance, comfort, and safety with Lakeland's trusted high-performance FR/AR layering system.

When you choose Lakeland's FR/AR Layering System, extreme weather and dangerous conditions won't compromise your safety or performance. The base layer is designed to pull moisture away from the skin to keep workers feeling dry. Mid layer garments are soft of hand and provide added warmth, insolation, and protection while maintaining moisture-wicking capabilities. The outer layers offer rugged protection from the elements, but also offer moisture-wicking capabilities and breathability.

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Announcer	Programmable Speakers in both panel-mount and stand-alone styles. **Up to 115dB!**
NEW! ***CAN Alarm***	A large, super-loud intelligent alarm that can be controlled on any **CAN J1939** network.
Audiolarm	The most widely-used industrial piezo alarm in the world.
M-80	The original high-output piezo alarm in a **small footprint**.
Turbo	Small, front-mount panel alarm that is half-the-size and twice-as-loud as industry counterparts.
Turbo Light	High intensity panel LED indicator available in **5 different colors**.
Ultra	A rear-mount piezo alarm that is **12 dB louder** and **1000 Hz lower** than industry counterparts.
Twin Turbo	A panel mount lighted piezo alarm that combines **bright light** with **loud sound**.

For our complete line of products, visit **www.FloydBell.com** or call **1-888-FLOYD-BELL**

Floyd Bell Inc

TAKE SAFETY INTO YOUR OWN HANDS

ARC RESISTANT GLOVES

FR Leather Lined with Kevlar® Wide-Cuff

12-3275-60

ANSI/ISEA	ANSI/ISEA	EN407
A4	5	4343XX
CUT LEVEL	PUNCTURE	

Arc Flash 25 Cal

FR Waterproof Ultimate Lined with Kevlar®

12-3290-60

ANSI/ISEA	ANSI/ISEA	EN407
A4	4	424344
CUT LEVEL	PUNCTURE	

Arc Flash 55 Cal

FR Ground Glove Lined with Kevlar®

12-3365-60

ANSI/ISEA	ANSI/ISEA	EN407
A4	5	4343XX
CUT LEVEL	PUNCTURE	

Arc Flash 37 Cal

14" Leather Protector

16-5100-14

ANSI/ISEA
5
PUNCTURE

Arc Flash 32 Cal

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WARNING: Youngstown's Arc Rated gloves and Leather Protectors do NOT protect against shock or voltage.