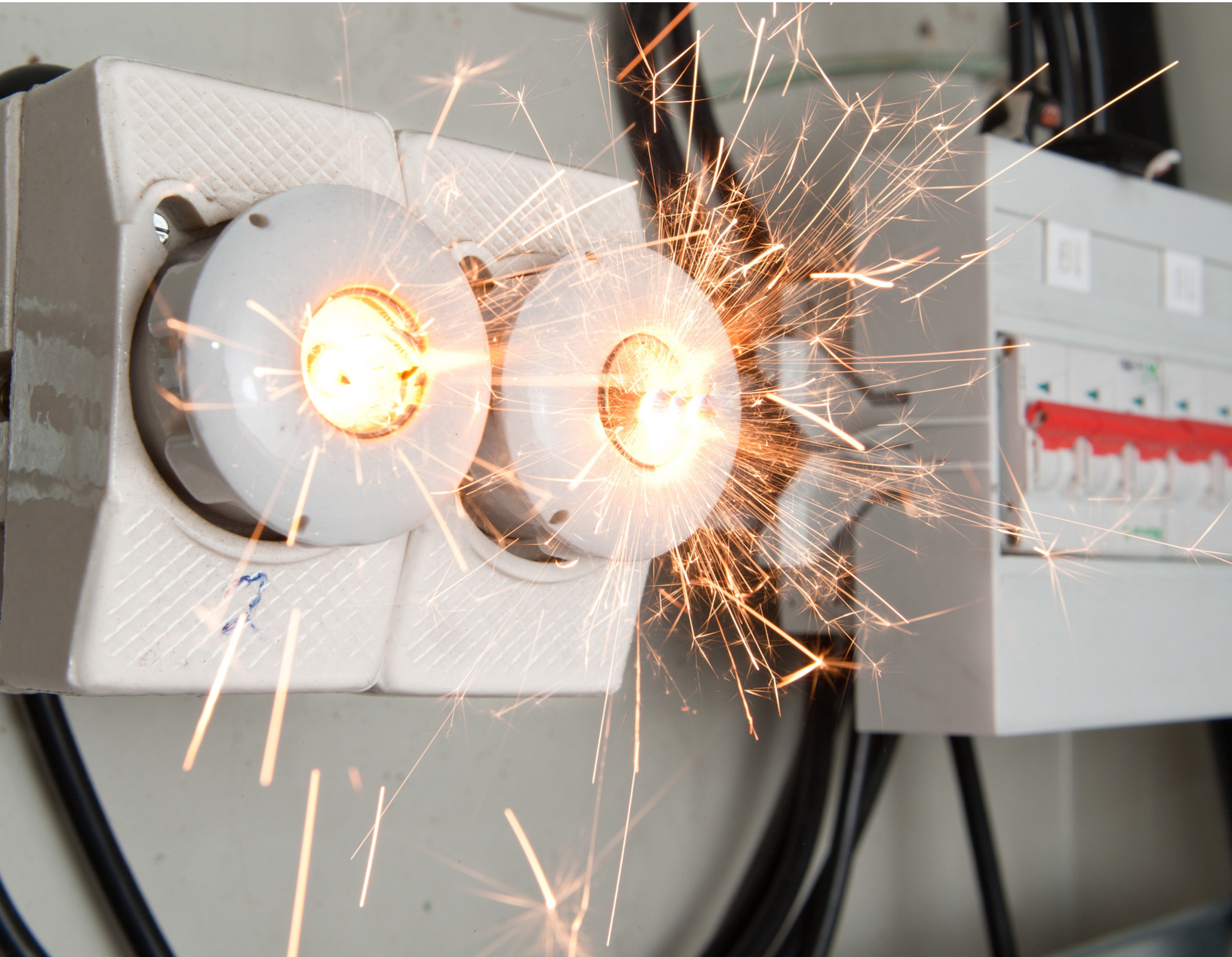
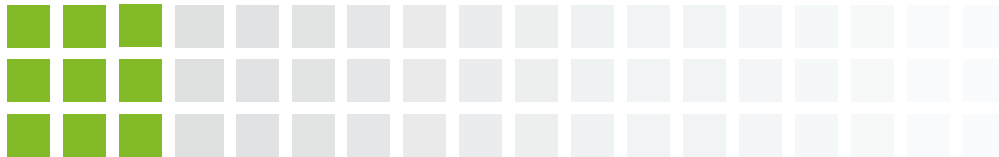


ARC-FLASH SAFETY

Survey Finds Need for Increased Safety Awareness



Safety Survey Results



Expertise Applied | Answers Delivered

Survey Finds Need for Increased Arc-Flash Safety Awareness

Many Facilities Fail to Conduct Arc-Flash Hazard Assessments and Provide Safety Training, Survey Finds

Electrical injuries carry special significance in part because they can be so devastating, according to the NFPA Fire Protection Research Foundation (FPRF). Despite the steady decline of electrical injuries in every industry other than mining, they are still a substantial cause of worker injury and fatalities, and accounted for almost 2,000 fatalities and over 24,000 non-fatal injuries in the U.S. between 2003 and 2012 [1]. The electrical fatality rate in the mining industry is about 8 to 12 times the worker fatality rate of overall U.S. industries [1].

These incidents often happen because of a lack of awareness. This can be a lack of awareness of the hazard itself, the proper PPE that must be worn in that facility, or even a lack of awareness of how much time has passed since the worker last familiarized themselves with safety standards (such as NFPA 70E).

“A substantial amount of work is inappropriately taking place on or around electrical sources that are energized, that stringent guidelines for personal protective equipment are frequently flouted, and that administrative controls, such as training and pre-job planning, are implemented or practiced haphazardly,” FPRF said [1].

Earlier this year, Littelfuse surveyed 255 people whose work plays a role in a facility’s electrical safety. This report looks at the results of the survey and how it relates to the bigger picture.

ONE IN THREE RESPONDENTS SAID THEY HAVE EXPERIENCED AN ARC FLASH INCIDENT.

The majority of the survey respondents work in facilities with equipment that is at risk for an arc flash. Slightly more than 75% of the survey respondents said their facility has equipment rated more than 8 cal/cm².

Above 8 cal/cm² is where arc-flash relays can make a substantial improvement toward industrial safety. An arc-flash relay that can decrease the calories from 10 cal/cm² to 4 cal/cm² will make a tremendous impact on the facility’s safety.

NFPA 70E moved away from using hazard risk categories to determine hazards and the level of protection in the standard’s last update.

Studies of high-risk industries indicate that human error is often a root cause of incidents [2, 7]. Human error is not only due to a lack of training. For example, a contributing factor to many electrical injuries is the failure to use appropriate personal protective equipment for electrical safety work practices [3].

The 2018 edition of NFPA 70E further evolved its requirements for risk assessment. One of these changes was the introduction of human factors, such as human error, as a consideration within a risk assessment.

NEARLY A QUARTER OF OVERALL RESPONDENTS SAID THEY HAVE NEVER RECEIVED SAFETY TRAINING AT THEIR WORKPLACE.

Research [1] indicates that “many workers who experience electrical injury have inadequate safety training to recognize safety hazards and follow proper procedures.”

Most arc burns are experienced by electrical workers working close to energized parts of high fault capacity [1]. Many of the worker electrical injuries examined by FPRF had insufficient training for working on or around energized electrical equipment.

A corporate case study examining electrical injury reporting and safety practices found that 40% of electrical injury incidents involved 250 volts or less and were indicative of a misconception of electrical safety as a high-voltage issue [1].

Even though electrical incidents are the leading cause of mining fatalities [3], most miners are unaware that the hazard of electrical arcs even exists [4].

Not only workers, but many managers and supervisors—even those who work in the electrical field—are not knowledgeable themselves about electrical hazards, even as they direct activities of employees to exposed energy sources [1].

Safety training is essential. It provides workers with the opportunity to do their best to protect themselves. However, keep in mind that any control method involving humans leaves the door open to human error. Eliminating the hazard, replacing (substitution) the hazard, or isolating people from the hazard (engineering controls) will always be a more effective means of protection than even the best safety training.

ONLY 66% OF RESPONDENTS SAID THEIR FACILITY HAS CONDUCTED AN ARC-FLASH RISK ASSESSMENT.

Arc-flash risk assessments determine the incident energy that employees risk being exposed to when they are near electrical equipment.

NFPA 70E Article 130.5 (Arc-Flash Risk Assessment) states that an arc-flash risk assessment shall be performed to 1) identify arc flash hazards; 2) estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health; 3) determine if additional protective measures are required, including the use of PPE.

Facilities that operate without regular shock and arc-flash risk assessments are like a driver on the highway with their eyes closed. They are cruising along blind to the risk their employees face.

The Hierarchy of Controls

The hierarchy of controls starts with the most effective and moves down to the least effective safety measure (see **Figure 1**). 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 deenergization 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). PPE is not the first line of defense, it is the last.

When asked which standards and codes they considered themselves to be familiar with, almost 85% of the respondents said they were familiar with NFPA 70E, Standard for Electrical Safety in the Workplace. However, when the next question asked, "are you familiar with the NFPA 70E's Hierarchy of Controls?" more than 40% of the respondents said no. A comparison of the data from these two questions suggests that more than a quarter of people who believe they are familiar with NFPA 70E are unaware of the latest edition's core concept. It is important to note that we cannot make the assumption that these respondents mistakenly believe they are familiar with NFPA 70E overall because we do not know which edition of the standard these respondents use, and the concept *Hierarchy of Controls* and the pyramid did not become a distinguished emphasis until the 2018 edition. Therefore, it is inconclusive how many of these respondents failed to retain the fundamentals of NFPA 70E or whether they are familiar with the

Hierarchy of Controls

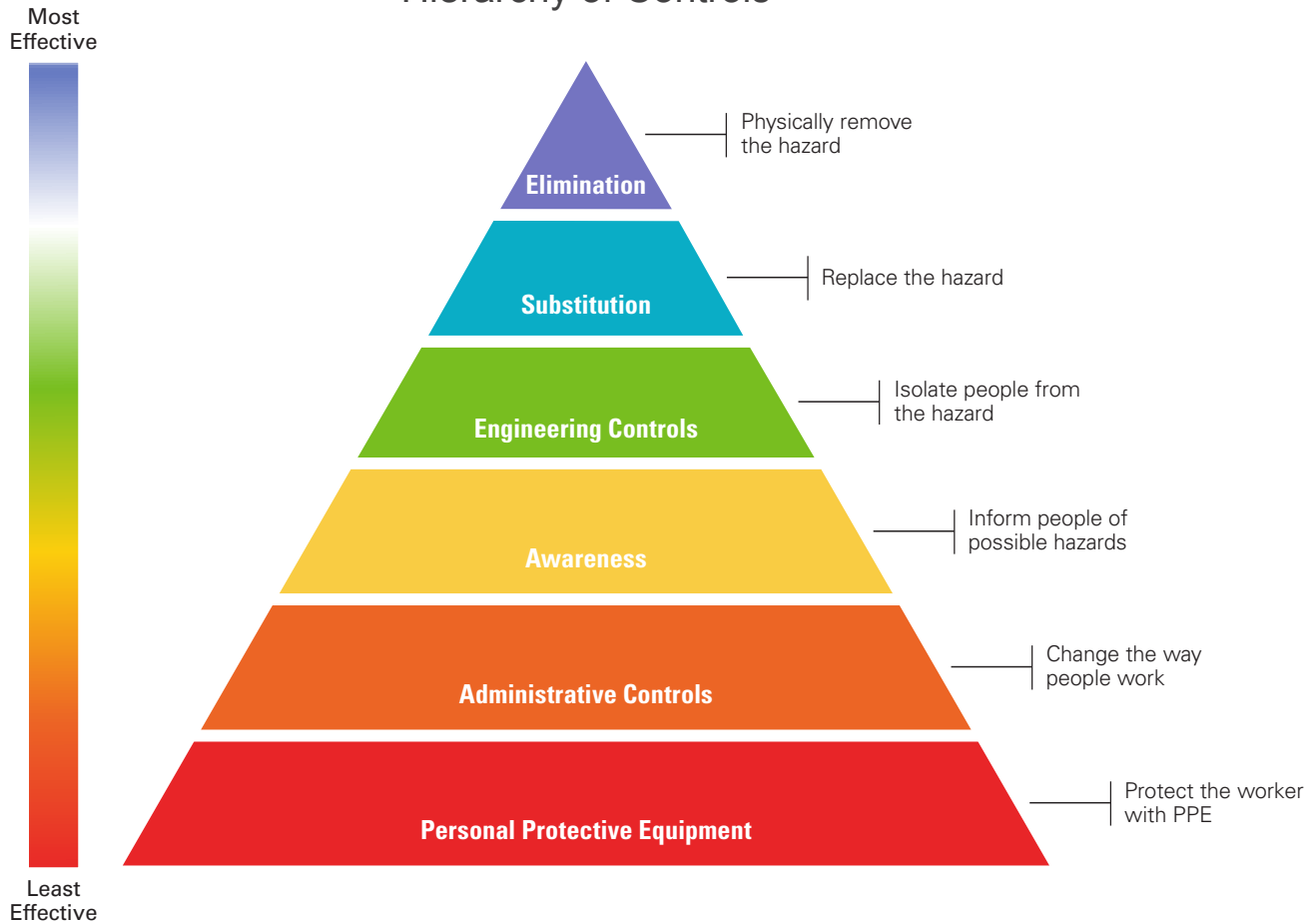


FIGURE 1. The hierarchy of controls starts with the most effective method of protection and moves down to the least effective measure.

standard's latest version. Regardless of which, they both amount to a false sense of familiarity, which runs the frontlines of most incidents. Standards (as well as the Code) are updated to drive continuous improvements in electrical safety.

This is concerning because a hierarchy of controls, as NIOSH says, has been the traditional means of determining how to implement feasible and effective control solutions. "Controlling exposures to occupational hazards is the fundamental method of protecting workers," NIOSH says. The hierarchy of controls is part of NIOSH's Prevention through Design national initiative [5].

PPE is a critical component of electrical safety and is not unimportant. However, it is considered the least effective safety method because it focuses on the

worker instead of the hazard [1] and does not address the hazard's root cause.

FPRF said they believe the practice of placing machinery and equipment in a deenergized state for troubleshooting merits additional research and safety training. "Of course," they continued, "efforts to promote prevention at the top of the hierarchy of controls, particularly through designing out hazards in the first instance, must remain a priority focus" [1]. Workers must always use safe work practices and wear the correct protection. Facilities must maintain this responsibility, while never losing focus of the top of the pyramid.

A clear understanding of the hierarchy of controls is fundamental to establishing a safe framework for workers (and equipment).

TABLE 1. Types of protection methods by risk hierarchy.

RISK HIERARCHY	SAFETY CONTROL BENEFIT	DESIGN-IN COMPONENTS
ELIMINATION	Remote diagnostics to avoid electrical exposure	Bluetooth-enabled overload relays
	Update grounding method	High-resistance grounding Neutral grounding resistor monitor
SUBSTITUTION	Updating older equipment	Current-limiting fuses Replace renewable fuses Indicating fuses Electromechanical relays
ENGINEERING	Reduce risk of electrical	Shock industrial GFCIs
	Limit arc-flash incident energy	Arc-flash relays Current-limiting fuses

MORE THAN 40 PERCENT OF RESPONDENTS SAID THEY WERE UNFAMILIAR WITH NFPA 70E'S HIERARCHY OF CONTROLS.

The 2018 edition of NFPA 70E—which features the Hierarchy of Controls Pyramid on its cover—was updated to emphasize the hierarchy of risk controls. While only 15% of the respondents were unfamiliar with the standard, more than 40% were unfamiliar with NFPA 70E's hierarchy of controls—which is the core of and featured on the cover of the 2018 edition.

The false sense of safety and awareness is tragic. Beyond mere complacency, FPRF identified a “normalization of deviance” among electrical workplace incidents.

Normalization of deviance is a process that initiates from a safety standard and then gradually deviates to what becomes an accepted practice, and effectively begins to operate as a new normal.

This is significant to the point of this article's discus-

sion because:

1. Normalization of deviance underscores how difficult it is for a facility to prevent human error within a framework. Because this deviation is gradual, it is difficult to detect as it or after it happens. Incidents are inevitable in facilities that do not focus safety on a minimum of engineering controls.
2. The gradual and easily undetected degradation that occurs in normalization of deviance is similar to how people often believe that they are knowledgeable—even masters—of their subject, and yet their is often an out-of-date version of the current reality. This might help explain why 40% of the survey respondents were not familiar with the Hierarchy of Controls and yet the majority of respondents said they were familiar NFPA 70E. The 2018 edition of NFPA 70E changed its discussion of the hierarchy of controls from conceptual to

emphasize it as established terminology.¹

NFPA 70E says to conduct a new analysis when changes that could affect the incident energy are made to an electrical distribution system. However, just as not all people stay current on safety standards and concepts, many facilities do not likely conduct new assessments whenever changes arise. Safe work practices must never deviate from standards. When any potential for hazards exists, safety should be kept in mind at every moment. However, consistent mindfulness is easier said than done.

Conclusion

Incident and fatality statistics are heart-breaking and life-ending stories. Thousands of workers are admitted to burn centers every year for the extended treatment of injuries caused by an arc flash. When engineering does not control the arc flash and other electrical hazards present, safety is not foolproof.

Implement designs focused on the reduction of human error. Nobody should ever assume they are safe, or that their awareness or knowledge of a situation or of a topic is complete.

If the top of the hierarchy of controls pyramid was always achievable—thus, the elimination of all hazards—there would be no injuries and fatalities. This is not always possible and when it is not, the next best option is to implement a substitution method, such as current-limiting fuses, indicating fuses or electromechanical relays. Otherwise, use engineering controls such as arc-flash relays.

To learn more about designing in electrical safety controls, go to [Littelfuse.com/IndustrialSafety](https://www.littelfuse.com/IndustrialSafety).

¹ Outside of NFPA 70E, the hierarchy of controls and its pyramid have been around for years and promoted by most major safety agencies around the world. The hierarchy of controls pyramid, for example, has been in ANSI/ASSP Z10 since the standard (then called ANSI/AIHA Z10) was first published in 2005.

References

- [1] R.B. Campbell and D.A. Dini, "Occupational Injuries From Electrical Shock and Arc Flash Events," Fire Protection Research Found. Quincy, MA, USA, Mar. 2015.
- [2] Standard for Electrical Safety in the Workplace, NFPA 70E, 2018.
- [3] "Mining Topic: Electrical Safety," Centers for Disease Control and Prevention, 21-Sep-2012. [Online]. Available: www.cdc.gov/niosh/mining/topics/ElectricalAccidents.html. [Accessed: 26-Apr-2019].
- [4] K. Kowalski-Trakofler and E. Barrett, "Reducing non-contact electric arc injuries: An investigation of behavioral and organizational issues", Journal of Safety Research, vol. 38, no. 5, pp. 597-608, 2007. Available: 10.1016/j.jsr.2007.06.004.
- [5] National Institute of Occupational Safety and Health, Hierarchy of Controls, cdc.gov. <https://www.cdc.gov/niosh/topics/hierarchy/default.html> (accessed April 24, 2019).



FOR MORE INFORMATION, VISIT
[LITTELFUSE.COM/INDUSTRIALSAFETY](https://www.littelfuse.com/industrialsafety)



Disclaimer Notice – Information furnished is believed to be accurate and reliable. However, users should independently evaluate the suitability of and test each product selected for their own applications. Littelfuse products are not designed for, and may not be used in, all applications. Read complete Disclaimer Notice at www.littelfuse.com/product-disclaimer.