Meeting the NFPA Electrical Cycle of Safety™

Cost Effective Solutions for Meeting the NFPA Electrical Cycle of Safety™

NTT Training

A DIVISION OF ECPI UNIVERSITY

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Executive Summary

The National Fire Protection Association (NFPA) promotes an "Electrical Cycle of Safety™", (ECoS™), to emphasize and address the importance of properly installing, maintaining, and working safely on electrical equipment. The three NFPA standards used to ensure compliance in these areas are:

1. *NFPA 70 National Electrical Code® (NEC®)*
2. *NFPA 70B Standard for Electrical Equipment Maintenance*
3. *NFPA 70E Standard for Electrical Safety in the Workplace®*

This white paper reviews the importance of this three-pronged approach for protecting people and property through risk management. Compliance explanations, practical examples, and specifically how NTT Training has and continues to support this approach are all addressed.

Managing Electrical Risk is a Legal Requirement

The Occupational Safety and Health Administration (OSHA) was created under federal statute through the Occupational Safety and Health Act of 1970 (OSH Act). Since then, OSHA continues to set and enforce their workplace safety regulations in the U.S. Those include requirements to assess and manage risks. Employers must comply with these laws and regulations to ensure a safe work environment. Practically speaking, these rules are only the minimum requirements for safety.

Compliance is the beginning to achieving a safe work environment. For organizations, compliance with federal administrative and regulatory laws limit liability, minimize the chance of workplace injuries and fatalities, reduce the possibility of structural fires, reduce downtime, and mitigate or prevent costly fines and private settlements.

OSHA regulations require that employees be protected from two currently industry-recognized electrical hazards: electrical shock and arc flash.[1]

While OSHA requires risk assessment in different sections of its legal requirements, it is the General Duty Clause, OSH Act Section 5(a)(1), that provides guidance for employers where specific OSHA rules do not adequately address employee protection. For example, while requirements for risk assessment and worker protection regarding respiratory

[1] A Better Understanding of NFPA 70E: Electrical Safety in the Workplace Applies to All Employers and Employees, Christopher Coache 18-Dec-2024, NFPA
https://www.nfpa.org/news-blogs-and-articles/blogs/2024/12/18/who-has-to-follow-osha-and-nfpa-70e

protection are addressed in 29 CFR 1910.134, no rules for protecting general industry workers from electrical arc flash hazards exist. Thus, it is the General Duty Clause that requires employers "to provide a workplace free from recognized hazards."

Statistics are readily available and support the need for risk mitigation when it comes to electrical hazards. During the period October 2023 through September 2024 there were 421 citations issued to electrical contractors totaling over two million dollars in fines. Of those, 81 of the violations were directly related to improper wiring as defined by the National Electrical Code, and resulted in over $83,000 in citations.[2]

The NFPA fire statistics for "non-home" locations due to electrical failures resulted in an estimated average of 16,540 fires each year from 2012–2016. These fires resulted in an average of 23 civilian deaths and 200 civilian injuries each year, as well as an estimated $637 million in direct property damage each year.[3] National Electrical Code violations are estimated to be involved in 36% of these fires, with lamps, bulbs, or lighting involved in another 10% of fires.

When it comes to personnel injury, much data exists for electric shock. BLS data compiled by the Electrical Safety Foundation International reveals 150 workplace electrical fatalities occur on average every year. It is important to note that 74% of these fatalities occur to non-electrical workers.[4]

In the *NFPA 70E Standard for Electrical Safety in the Workplace*, OSHA estimates that an average of 12 nonfatal and 2 fatal arc burn injuries occur each year.[5] The standard also

A recent case involving a failure to properly assess and manage an electrical risk occurred at a Texas auto manufacturing facility in August 2024. An electrician died by electrocution while inspecting an electrical panel that was unexpectedly energized.
OSHA investigated and identified several safety violations created by the manufacturer, including:

- Failure to Provide Adequate Protective Equipment:
- Allowing Work Near Unprotected Electric Circuits
- Lack of Warning Signage

OSHA issued the auto manufacturer three "serious" safety violations resulting in fines of $49,650. In addition to the OSHA citations, the electrician's family filed a wrongful death

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[2] Frequently Cited OSHA Standards Results NAICS Code: 23821 *Electrical Contractors and Other Wiring Installation Contractors*
https://www.osha.gov/ords/imis/citedstandard.naics?p_esize=&p_state=FEFederal&p_naics=23821
[3] NFPA Research Non Home Electrical Fires https://www.nfpa.org/education-and-research/research/nfpa-research/fire-statistical-reports/non-home-electrical-fires
[4] Workplace Electrical Fatalities 2011-2023, ESFI https://www.esfi.org/workplace-safety/workplace-injury-fatality-statistics/
[5] NFPA 70E Standard for Electrical Safety in the Workplace, 2024 edition, Annex K, section K.3

lawsuit asserting negligence based on the OSHA findings. It was obvious that the electrical worker had not been properly trained to recognize and mitigate electrical hazards. Failure to recognize the risk of inadvertent energization of the equipment and methods necessary to mitigate that risk resulted in the fatality. Once the risk was identified, proper management through written hazardous energy control procedures, use of appropriate personal protective equipment (PPE), signage and training could have been used to most likely prevent injury.

This case underscores the severe consequences that can arise from inadequate assessment and management of electrical risks, thus highlighting the necessity for stringent safety measures in the workplace.

Statistics and this typical case history indicate a strong need for better risk assessment and mitigation techniques for electrical tasks. Meeting business needs, complying with state and federal regulatory requirements and creating a safe work culture creates the best situation for both employer and employee.

Three Standards to Reduce Risk

The National Electrical Code (NEC) was first implemented in New York City in the 1880's to reduce fire risk and injury. It consisted of one page of electrical equipment installation and operation requirements. The NEC has since evolved to well over 800 pages of technical information yet has the same purpose: "Protect people and property from the hazards arising from the use of electricity."

This electrical building code is enforced in all 50 states, revised every three years and often used by global corporations as an electrical installation code. Other countries may also use the National Electrical Code to meet their safe installation needs. It is important for employers to note some general statements found at the beginning of the NEC:

- 90.2(A) "This *Code* is not intended as a design specification or an instruction manual for untrained persons."
- 90.2(B) "This *Code* contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use."
- 110.17 Servicing and Maintenance of Equipment. "Servicing and electrical preventive maintenance shall be performed by qualified persons trained in servicing and maintenance of equipment and shall comply with the following . . ."
- Article 100 Definitions "Qualified Person. One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved."

The National Electrical Code is the recognized source for safe electrical installations. Without servicing and preventive maintenance an installation cannot be expected to remain safe. Because of the complexity of electrical systems and equipment qualified persons are required to install and maintain the equipment.

The *NFPA 70B Standard for Electrical Equipment Maintenance* moved from a recommended practice to a standard in 2023 thus making it available for OSHA citations. The purpose of this standard is to "provide for the practical safeguarding of persons, property, and processes from the risks associated with failure, breakdown, or malfunction and a means to establish a condition of maintenance of electrical equipment and systems for safety and reliability." In short, NFPA 70B is about personnel safety first, and then about reducing downtime.

Attempts to address electrical maintenance issues for personnel safety first surfaced in the 1940's with the greatly increased manufacturing during the war effort. It wasn't until the 1970's that electrical maintenance practices were first addressed formally when NFPA 70B Recommended Practice for Electrical Equipment Maintenance was introduced. As statistics were tracked and increased interest in the safety culture evolved, the need to make electrical maintenance mandatory was formalized in 2023.

The NFPA 70B standard documents the need for electrical maintenance[6]:

- Lack of Cleaning Program Causes Switchgear Damage. Damage amounting to $100,000 was attributed to the failure of the main switchgear at an industrial facility. Fouling by dirt, gummy deposits, and iron filings caused the failure. The cost of this failure would have supported a comprehensive Electrical Maintenance Program covering all the plant's electrical distribution system for several years.
- Failure to Maintain Extension Cord Causes Fire. A large exhibition hall in Chicago was destroyed by a fire believed to have been started because of a defective extension cord serving a display booth. Direct property loss was $60 million, and loss of the facility cost an additional $100 million to the economy in the Chicago area. This fire might have been prevented if a program had been in effect to manage the integrity of the cords.
- Fatality due to an Explosion in an Electrical Room: In a plant, two electricians were servicing programmable logic controller (PLC) equipment in the main motor control center (MCC). During the electricians' break, an explosion occurred in the main circuit breaker section of the MCC. One of the electricians had his back to the enclosure when the explosion occurred. His clothes caught fire and he was severely burned and eventually died from his injuries. The second electrician suffered smoke inhalation, minor burns, and PTSD. The forensic investigation into this failure revealed the MCC's owner never maintained nor inspected the MCC during its over 25 years of service, despite requests from the plant's own maintenance staff."

[6] NFPA 70B Standard for Electrical Equipment in the Workplace, 2023 edition, Annex L Case Histories

To reduce risk from maintenance issues the NFPA 70B Standard for Electrical Equipment Maintenance provides requirements for the establishment of a documented maintenance program, identification of equipment to be included in the program, maintenance frequencies and a variety of electrical tests to be performed. Keeping equipment safe over its lifetime is the key requirement of NFPA 70B.

The *NFPA 70E Standard for Electrical Safety in the Workplace* provides the needed guidance for employers and employees to comply with the OSHA requirements for safe electrical work in both construction and general industry. OSHA requires hazard and risk analysis, PPE usage and implementation of safe work practices. It does not, however, tell organizations and individuals how to meet these requirements. This is the value of the NFPA 70E standard; it is the "how-to" document that gives employers and employees the detailed tools they need to meet OSHA requirements and work safely on electrical equipment.

Electrical accidents in U.S. industries result in significant financial burdens, encompassing both direct and indirect costs. According to the OSHA, the average direct cost of an electric shock injury is approximately $158,218. When accounting for indirect costs—such as lost productivity, training replacement employees, and accident investigations—the total cost can be substantially higher. The National Safety Council reports that the average cost per medically consulted injury in 2022 was $40,000, and the cost per workplace fatality was $1,390,000.[7] Given the frequency of electrical injuries and fatalities, a documented electrical safety program is more than just a requirement, it is a business and moral obligation of employers.

Implementing stringent electrical installation, maintenance and electrical safety protocols is proven to pay dividends. After adoption of the NEC, NFPA 70B and NFPA 70E into a formal program specific for a facility, employers must assure workers who apply these three standards are "qualified persons" in compliance with state and federal safety programs. Employers need to train employees, ensure they have the right tools and PPE to do the job and conduct field audits compliance and understanding.

Implementing an Electrical Cycle of Safety™

The NFPA identifies the use of "three essential codes and standards—known as the Electrical Cycle of Safety™ (ECoS™) —to help ensure a safe, reliable, and effective approach to achieving comprehensive electrical safety."

[7] Make the smart investment for electrical safety https://www.plantengineering.com/articles/make-the-smart-investment-for-electrical-safety/?utm_source=chatgpt.com

"When used collectively, these codes complete the Electrical Cycle of Safety. Where just one is missing, it could result in preventable incidents that put people, property, and critical processes at risk."

Implementing an Electrical Cycle of Safety™ requires employers to:

- Verify all installation work is inspected and in accordance with requirements
- Establish, document and implement an electrical maintenance program
- Establish, document and implement an electrical safe work program
- Train and qualify workers on the necessary risk assessment methods to protect themselves/ This includes periodic retraining
- Verify through work practices audits that qualified persons are performing all electrical work in accordance with procedures

The requirements to become a "qualified person" are specified in federal OSHA and state programs, the NEC for installation tasks, NFPA 70B for maintenance tasks and NFPA 70E for safe work practices. Employers must document worker qualifications in three areas:

1. Knowledge in the construction and operation of the equipment
2. Skills necessary to complete the task, and
3. Safety training to recognize and avoid hazards

Employees must comply with employer safety policy and procedures, use and maintain PPE and report any hazards found.

Managing risks through an Electrical Cycle of Safety program is a commonsense approach to protecting property and keeping people safe. "Build it Safe – Keep it Safe – Work on it Safely" has been the focus of NTT Training for many years.

Effective Solutions for Organizations

Collaborating with clients on a national and global scale over the years, NTT has identified several items to help organizations effectively manage risks. Following are simple ideas for consideration:

- Using multiple training programs or suppliers to meet training requirements often results in redundant programs, cost inefficiencies and worker frustration.
- Training should be based on plant and facility specific needs. For example, management staff should be trained on the three documents of the Electrical Cycle of Safety. Management must be aware of the hazards and know of the tools used to manage those risks. Workers should be trained on work procedures.
- Programs developed should be specific to an organization and not the generic requirement of a standard.
- Procedures must be usable and specific for the worker in the field.

- Use one source for program development from initial analysis through procedure and training program development. Whether these tasks are conducted in-house or outsourced, inefficiencies, program overlaps, and cost overruns result with multiple suppliers.

Following are examples of solutions created by NTT Training to meet client requests in a cost-effective manner.

(Florida). Matching electrical safety training with NEC training to not only reduce risk from workforce incidents but assist workers with installation requirements of large retrofit projects reduced the total number training days required. Because of NTT's commitment to client needs to add-on state and local regulations material the client can utilize their NTT provided hands-on electrical safety training for employees to meet local and state electrical licensing renewal requirements.

(DRPA) Working with the state licensing authority, NTT received approval for licensed electricians to receive required licensing renewal hours while performing hands-on training exercises on medium voltage systems and equipment.

(Summit) A major oil producer required a contractor to meet their electrical safety training requirements before coming onsite. To obtain the work the contractor came to NTT, who had written the oil producers electrical safety program, to provide the training. NTT developed and presented specific electrical safety and equipment application training that well exceeded program requirements. The contractor now performs work worldwide for their client.

(Saudi Aramco) A major overseas oil producer had a unique need to provide hundreds of their engineering staff with installation, personnel safety and equipment maintenance training, (Electrical Cycle of Safety). The training had to incorporate some local and all U.S. codes and standards. NTT designed and developed training for multiple overseas locations.

(Ford). After sustaining significant OSHA fines due to a worker injury, a Fortune 500 manufacturer turned to NTT to resolve OSHA concerns. Developing electrical safety training programs, consulting on PPE purchases, and through meeting with arc flash study engineers, NTT was able to develop a successful program satisfactory to OSHA and then trained over one (several?) thousand electrical workers in safe work practices.

Once a successful Electrical Cycle of Safety™ is established within an organization, some organizations find it more cost effective to bring this training and program development in-house. NTT has developed and implemented organizational specific train-the-trainer programs. Costs are reduced and efficiencies improved.

Conclusion

Implementing effective electrical installation, maintenance and safety programs is not only a requirement, but a cost-effective means to improve safety and reduce downtime. The National Electrical Code, the NFPA 70B Standard for Electrical Equipment Maintenance and the NFPA 70E Standard for Electrical Safety in the Workplace are the three documents identified by the NFPA to implement an Electrical Cycle of Safety™. Efficient solutions include development of practical programs and procedures, hands-on training, and safe work audits to ensure all components of the program are working effectively. NTT Training is an organization with a lengthy and proven track record of developing and implementing an Electrical Cycle of Safety for organizations.