EPiC Series in Built Environment

Volume 6, 2025, Pages 875–882

Proceedings of Associated Schools of Construction 61st Annual International Conference

Identifying Electrical Risks and Enhancing Safety Training for Non-Electrical Construction Workers

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Construction is an inherently dangerous industry, with electrocution being a leading cause of worker fatalities. While electrical workers face obvious risks, non-electrical workers are also vulnerable to electrical hazards. This research, through interviews with both electrical and non-electrical workers, identified key themes in electrical safety, including hazard recognition, preventive measures, and emergency response. The findings underscore the importance of targeted electrical safety training for non-electrical workers to improve their understanding of electrical hazards and enhance safety practices. By implementing effective training programs, construction companies can significantly reduce the risk of electrical accidents and fatalities. Recommendations include focused training on hazard identification, safe work practices, and emergency response procedures. Regular safety meetings and ongoing training can further reinforce safety knowledge and foster a culture of safety. Prioritizing electrical safety training is essential to creating a safer and more productive work environment for all construction workers.

Keywords: Construction safety, Focus Four, Electrical hazards, Safety training

Introduction

The construction industry is one of the most dangerous industries in the U.S., accounting for 19.9% of workplace fatalities in 2022, despite employing only 7.5% of the workforce (Trueblood, Harris, & Yohannes, 2024). Of the 1,069 fatal accidents in construction in 2022, 145 of them were due to exposure to electricity. Incidents involving exposure to electricity include electrocution, fires started by electrical errors, and electrical burns.

Known as the “focus four” or “fatal four,” the four most common causes of fatalities on construction sites are falls, electrocution, being struck by objects, and being caught in or between objects (Harris, Yohannes, & Trueblood, 2023)." Electrocution is one of the top four causes of worker fatalities in the US construction industry. Without formal training, electrical mishaps can happen to anyone, regardless of their trade so it is not just those working with the electrical systems that are at risk.

Therefore, educating non-electrical workers with appropriate electrical safety training is essential to prevent accidents and maintain a safe working environment on construction sites (Brenner & Majano, 2020). The fundamentals of spotting potential risks, operating electrical equipment securely, and comprehending pertinent jargon will all be covered in this paper.

Electrical safety on construction sites is a shared responsibility between employers and workers. Known as the General Duty Clause, section 5(a)(1) of the Occupational Safety and Health Act of 1970 (OSH Act) requires each employer to provide workers a safe workplace free from recognized hazards by implementing the proper safety procedures and providing necessary tools and training. The training can be a part of a periodic schedule training, weekly pre-planned training, or just-in-time training that is particularly helpful when the goal is skill development (Branzetti et al., 2017). Employers can take additional practical measures to encourage electrical safety on construction sites and provide the appropriate training. For example, the literature suggests that employers conduct regular inspections of electrical wiring and equipment to ensure they are in good working order and free from damage. Additionally, they can set up specific protocols for reporting any problems or concerns relating to electrical safety.

Improving electrical safety on construction sites requires appropriate training, efficient employer-employee communication, and a dedication to upholding secure working environments. By implementing these measures, employers can prevent accidents, safeguard the health and welfare of their employees (Neitzel & Gauthier, 2014), and ensure the speedy and safe completion of projects (Mohammadi et al., 2018). Electrical safety training is an essential aspect of the overall safety program as it is a leading cause of fatalities in construction. Statistics show that non-electrical workers are more prone to electrical fatalities than their electrician counterparts (Brenner & Majano, 2020). Due to this, electrical training for non-electrical workers is essential.

Literature Review

Maintaining a safe workplace is both a legal and moral imperative in all industries and has led to robust awareness and training programs in the construction industry (Pham et al., 2023). Construction sites are well known for being dynamic, quickly changing settings where numerous trades operate alongside heavy machinery, tools, and chemicals (Alsharef et al., 2020), meaning special care is required to manage all these ever-changing scenarios and workers. Also, workers cannot recognize most of the hazards (Uddin et al., 2020). This means workers may not be able to identify many hazards that may lead to accidents. Most safety programs are designed to mitigate recognized hazards, which means there is a gap between what is needed and what is offered. Since fatalities due to exposure to electricity are among the fatal four, it is particularly important to close this gap with respect to electrical safety.

The construction industry's electrocution rate is 9.3 times higher than the average of all other industries (Zhao et al., 2016). In addition to the lives lost, electrocution has a significant financial impact. Electrical injury has the second-highest cost per nonfatal case ($86,829) and the highest cost per fatal case ($948,844) in the construction industry (Zhao et al., 2016). The construction industry has several types of electrical hazards, such as overhead power lines, electrical equipment and wiring, lighting fixtures, machines, and applications. These impacts of various hazards differ for electrical and non-electrical workers (Anderson et al., 2021), which depicts the different understanding levels of electrical hazards for workers with different backgrounds.

Sixty four percent of all fatalities due to electricity exposure happened in occupations outside the electrical field (Brenner & Majano, 2020), which means a majority of these fatalities are not due to working around electrical equipment and supply like electricians are. According to research by the Electrical Safety Foundation International, during the past 10 years, contact with overhead power lines has been the leading cause of electrical fatalities (Albert & Hallowell, 2013), which can be employees of various trades. Other leading causes for non-electrical workers are machines, appliances, tools, and lighting fixtures. (CPWR, 2018).

Between 2015 and 2019, OSHA investigated 316 fatalities due to electrocution across 310 incidents (Jenkins, 2023). The majority of these fatalities (52.9%) were caused by electrical shock from exposed wires. Electrical contractors accounted for only 31% (96 out of 310) of electrocution fatalities during this period which means a notable majority of electric shock fatalities were of non-electrical workers which indicates a need for better training and preparedness of these employees. While the 96 fatalities to electrical workers indicates there are still gaps in safety systems and training for electricians, the larger number of fatal incidents involving non-electricians highlights the need for further exploration of this area. There is a direct relationship between training and work-related injuries (Jafari et al., 2014; Lee et al., 2022) with much of it being focused on the specific tasks associated with employee role. This paper aims to investigate the potential need to broaden how employees are trained regarding electrical hazards.

Purpose of the Research

The purpose of this paper is to evaluate the preparedness of non-electrical workers as they encounter electrical hazards on construction sites by investigating perceived hazards, current safety training approaches, and potential new training methods tailored to their needs. By implementing efficient electrical safety training programs for non-electrical personnel, the paper offers insights and suggestions for enhancing the overall safety environment in the construction industry. The following research questions were considered in pursuit of this purpose.

1. What are the most common electrical hazards that non-electrical workers in the construction industry are exposed to, and how can these hazards be mitigated through electrical safety training programs?
2. How effective are current electrical safety training programs for non-electrical workers in the construction industry in preventing accidents and injuries related to electrical hazards?
3. What topics should be the focus when delivering electrical safety training to non-electrical workers?

Methodology

The research design for this paper is a qualitative method approach. Specifically, a phenomenological process was used to capture the experiences of participants that shed light on the process of training workers in different fields on electrical hazards. Data was collected via one-on-one semi-structured interviews of ten people from various areas of the construction industry. Participants were recruited via snowball sampling. The first round of participants was recruited through initial contacts in the industry and information about later participants was collected from the first round of participants. To provide a thorough examination of the participants' experiences, viewpoints, and ideas about electrical safety training for non-electrical construction workers in the construction sector, a semi-structured interview procedure with open-ended questions was designed. Depending on the participants ' preferences, the interviews were done in person or via audio/video conferencing.

Sample

The sample of this study includes five electrical and five non-electrical workers from various construction trades at different levels of experience. The sample was delimited to individuals working in the commercial construction sector. This was due to the nature of the types of projects and the higher number of non-electrical workers that would be working on a project at the same time as the

electricians which allowed for insight into the potential interplay of multiple trades on site at once. All the participants have site experience and have undergone some safety training. Data saturation was achieved after the ten interviews with no new themes or insights coming out with the final participants so, therefore, no additional interviews were conducted..

Results

The data were coded, categorized, and organized into themes with the final analysis broken down by how the themes apply to electrical and non-electrical workers. This was done through a frequency analysis of the coded responses of each participant. While the primary consideration was frequency of comments, the degree of emphasis on particular comments was also considered as how it might shed light on comments of other participants.

The main focus of the analysis was to assess the basic understanding of problems associated with non-electrical background workers regarding electrical-related incidents and how the current condition could be improved. Having them set in comparison to electrical workers' perceptions helped to highlight important concepts. There were four primary themes identified as particularly important.

Theme: Perceptions of Risks and Hazards

Once a hazard has been identified, necessary training can be designed accordingly. During the interviews, when questions were asked about the potential risk of working with or near electrical equipment, three out of five people from an electrical background stated their belief that electrocution is the leading risk. They noted that workers getting shocked is a common phenomenon when they are involved in working with electrical.

When the same question was asked of the non-electrical background participants, three out of five people said that the risk of shock or electrocution is the main danger when working with or near electrical equipment. Two out of five people from non-electrical backgrounds said that the main risk is the cold-to-hot transition or de-energized to energized phase, which poses a substantial risk.

Theme: Onsite Events and Violations

To understand the gravity of a breach of safety rules, workers need to be aware of how things can go wrong if they do not follow the safety rules. Electrical background participants were asked about the repercussions of failing to adhere to electrical safety and their response if a co-worker were to violate electrical safety regulations. Three out of five electrical background participants said that electrocution or shock would be the main repercussion if electrical safety gets violated. Two out of the five noted the possibility of fatality. A majority of participants said that removal from the site could result from electrical safety violations. All five participants said that if their co-worker were to violate electrical safety regulations, they would stop and explain the offense to them with most of those saying they would inform seniors about this violation.

When similar questions were asked of non-electrical background participants, three out of five participants said that shock or electrocution would be the result of violating electrical safety. Two out of the five mentioned the possibility of fatality if a safety violation occurred. Three participants said that removal from the site would be the main repercussion in case of electrical safety violation. All five of the non-electrical participants said they would stop or remove the co-worker from that situation if they were violating electrical safety regulations but only two said they would inform the senior about this violation.

When participants were asked about their experience regarding electrical accidents, four out of five electrical background people stated that they were involved in some incidents related to electrical hazards. Two of the five non-electrical participants reported having been part of some electrical incidents.

Theme: Training for Hazard Identification

Once potential hazards have been identified, the next step is to design the training which should include the strategies to mitigate them. When questions were asked from electrical background participants regarding the most often used electrical safety precautions, all five participants said they were mindful of lockout and tagout. Interestingly, only two of the electrical background participants mentioned ground fault current interrupter (GFCI), and the same number of participants said that they are aware of specially designed PPE, which is required when working near high voltage panels. It is possible that the ubiquity of GFCI devices was the reason for the minimal mentions.

When the same questions were asked of non-electrical backgrounds, three out of five participants said they knew the lockout and tagout process. One participant said removing batteries from equipment when not operating is crucial to avoid accidental turn-on. Two participants said proper zoning, barricading, and appropriate signage are vital during a cold-to-hot transition.

Theme: Preventive Measures and Responses

Safety devices and systems are put in place as preventive measures to create safe conditions in a workplace. Along with these physical systems, procedures among workers round out a safety program that will lead to both safe conditions and safe actions. Training programs are a common method used to support understanding and compliance with the procedures. All the participants from both backgrounds had completed some company-mandated safety training.

Participants were asked how they would ensure that they will not get electrocuted when working with electrical tools or if they are working near an electrical line. Four of the participants with an electrical background said that GFCI protection is crucial for equipment. Two participants said that tool integrity is vital and four stated that maintaining a safe distance from the power line is critical.

When similar questions were asked of participants of non-electrical backgrounds, three out of five stated that GFCI protection is essential. Two participants said that checking the tool's integrity is critical to safety when working with the tool. Four participants mentioned the importance of maintaining a safe distance from power lines and two said that proper PPE designed for specific purposes is also an important point to be considered.

When participants were asked what they would do in an electrical emergency, most people with an electrical background said they would separate the person and then try to provide first aid medical services to the affected person. Conversely, 4 interviewees with a non-electrical background said they would contact a safety manager rather than directly coming to the individual affected by the electrical exposure emergency. These disparate plans to an electrical emergency could be attributed to their different knowledge level about hazards and electrical systems. An electrician knows about electrical systems and how to switch off the supply and separate the affected person from the electricity. However, non-electrical workers may not know enough about addressing electrical safety hazards, which may explain the different responses.

Overall, a failure to identify electrical hazards is the primary source of injury risk for non-electrical construction workers. Fortunately, this is an issue that can be mitigated by purposeful safety training.

Conclusion

Electrical hazards pose a risk for electricians and non-electrical personnel alike. The non-electrical workers are particularly at risk because they frequently lack knowledge and expertise in working with and around electricity. Therefore, an essential part of creating a safe construction site would be to equip non-electrical workers with the knowledge to identify hazards associated with electricity and the skills to mitigate hazards and respond to emergencies.

This critical training on electrical hazards needs to be tailored for non-electrical workers and be different from the training that electricians receive. For non-electrical workers, the training should open with general electrical hazard identification followed by a focus on a few electrical procedures, such as lockout and tagout, tool inspections, and GFCI protection. Small-scale interdisciplinary training would also be effective such as an electrician attending a toolbox talk safety meeting. Another strategy would be to involve electrical experts in the inspection and review of work areas and procedures to point out some of the potential hazards.

Results indicate that particular attention be paid to the stage of the project when the electrical supply is turned on and the electric panels are energized, known as the point when the site converts from cold to hot. This is an opportunity to provide all workers on site with just-in-time training, a method that is demonstrated to be effective in skill acquisition.. At this time, the new hazards can be discussed along with the safety measures in place for hazard mitigation. It is critical that this takes place early in the project before the site goes from cold to hot.

The findings suggest training also include how to respond to an electrical emergency. A proper chain of command should be part of the training so that every non-electrical worker is prepared to react in the same manner every time. It is essential to formulate these strategies at the corporate level to ensure the implementation of strategies uniformly and consistently in all projects. This will improve the downstream implementation.

Opportunities for further research include a focus on the effectiveness of this focused purposeful training and the potential for specific industry-wide requirements for it. While training on electrical hazards is mandated as part of OSHA's outreach training program (OSHA, n.d.), this component can be made more granular such as requiring discussions of tool inspections, de-energizing equipment after use, emergency response, lock out/tag out, GFCI protection, and proximity constraints.

These topics are critical to reinforce through regular on-site safety meetings. With these practices, employers can create a safer and more effective workplace for everyone by giving all employees the knowledge and abilities to work safely around electrical equipment.

Limitations

The paper's limitations include the fact that there were only 10 participants. While the qualitative approach allowed for a richer data source, the small number of participants may limit generalizability. Additionally, the paper focuses on the perspective of employees and employers and may not capture the views of direct craft workers and other stakeholders, such as customers or suppliers. The paper focuses exclusively on individuals whose experiences are in the commercial sector and in the Oklahoma and Texas region.

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