

Electrocutions and Prevention in the Construction Industry

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Electrocution is a leading cause of fatalities in construction, and has been identified as one of the Focus Four hazards by the U.S. Occupational Safety and Health Administration (OSHA), along with falls, caught-in-between, and struck-by (OSHA, 2011). Electrocutions can occur in many ways among different occupations. To better understand electrocutions among construction workers, and provide updated information for electrocution prevention, this Quarterly Data Report analyzed the trends and patterns of deaths due to electrocution, including primary sources of electrocution, vulnerable worker groups, and high-risk occupations. Because the number of nonfatal injuries caused by electrical hazards is small, this report only focuses on fatal injuries from electrocution. Numbers of fatalities were obtained from the Census of Fatal Occupational Injuries (CFOI) and employment data were from the Current Population Survey (CPS). Both the CFOI and the CPS data are collected by the U.S. Bureau of Labor Statistics (BLS). To emphasize the importance of intervention, this report also includes solutions to prevent electrocutions selected from multiple sources, including OSHA, the National Institute for Occupational Safety and Health (NIOSH), and CPWR.



KEY FINDINGS

- Between 2003 and 2015, the number of electrocution deaths in construction decreased by 39% compared to the 16% reduction in overall construction fatalities.
- Despite the reduction, 82 construction workers died of electrocution in 2015, comprising 61% of all work-related electrocution deaths in the nation that year.
- About 32% (115 out of 364) of electrocution fatalities occurred among electrical contractors, more than any other subsector in construction.
- One hundred and five electricians died of electrocution in construction, more than any other occupation from 2011 to 2015, but power-line installers had the highest rate of electrocution deaths of any occupation.
- Workers aged 35-44 comprised the largest proportion of electrocution deaths of any age group; however, workers under 25 suffered the highest rate of electrocution fatalities.

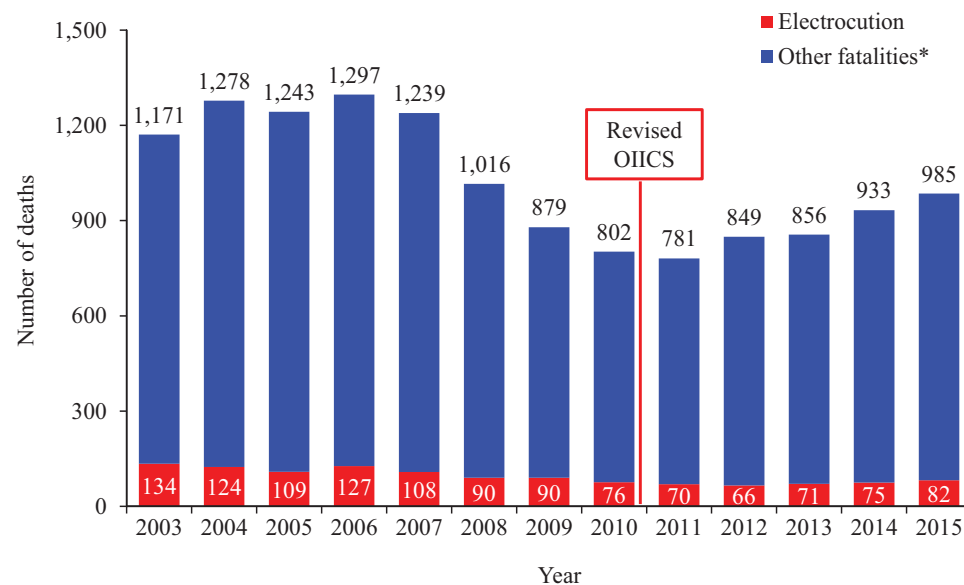
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Image: eLCOSH Images

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SECTION 1: Trends of Electrocutions in Construction

The trend of electrocution deaths¹ in construction dipped during the recession and rose after, mirroring the overall fatality trend (chart 1).² In 2015, there were 82 electrocution deaths among construction workers, a 17% increase from 70 deaths in 2011, but less than the 26% increase in overall construction fatalities during the same time period. On average from 2003 to 2015, about 9% of construction fatalities were from electrocution. During this period, the number of electrocutions decreased by 39% compared to the 16% reduction in overall construction fatalities, continuing a longer declining trend of electrocution (Dong et al 2010; Wang et al 2015) and suggesting intervention on construction electrocution is relatively effective.

1. Number of fatalities in construction, electrocution and other fatalities*, 2003-2015



¹Electrocution deaths in this study include “exposure to electricity” (Event codes 51xxxx in OIICS 2.01) and “contact with electrical current” (Event codes 31xxxx in OIICS 1.01).

²In 2011, the Census of Fatal Occupational Injuries (CFOI) switched to OIICS version 2.01, therefore numbers before and after 2011 are not directly comparable.

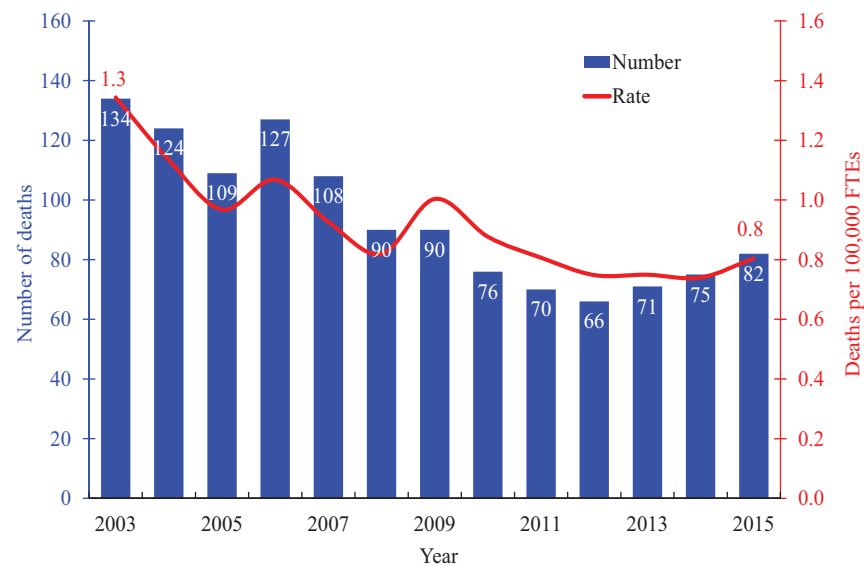
* Other fatalities are fatalities from all causes except electrocution.

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

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The rate of electrocution deaths in construction has fallen along with the overall number of fatalities. In 2015, there were 0.8 electrocution fatalities per 100,000 *full-time equivalent* workers (FTEs), a 40% decrease from 1.3 per 100,000 FTEs in 2003 (chart 2). However, the rate increased about 9% from 2014 to 2015.

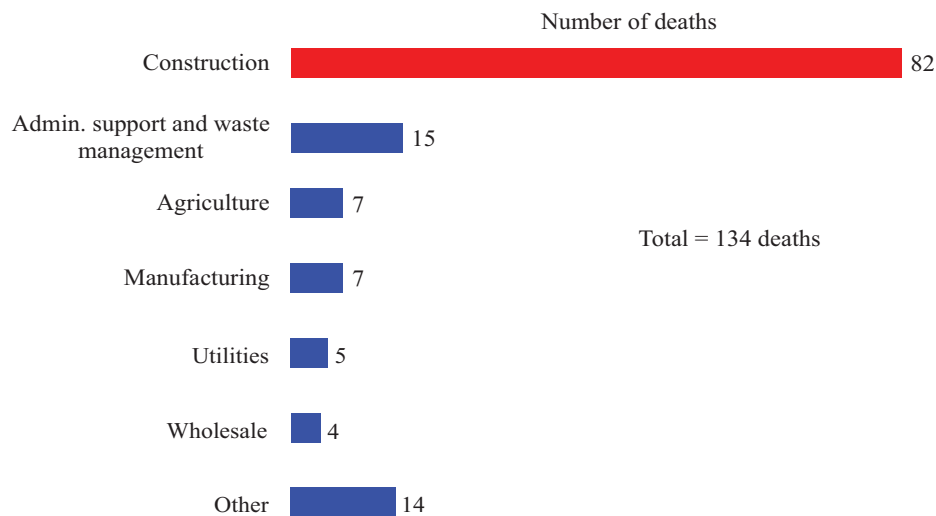
2. Number and rate of electrocutions in construction, 2003-2015

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

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Despite the reduction, in 2015, construction had the highest number of electrocution deaths among all industries, more than five times as many as in administrative support and waste management - the industry with the second-highest number of electrocutions (chart 3). Overall, electrocution fatalities in construction comprised 61% of all occupational electrocution deaths nationwide that year.

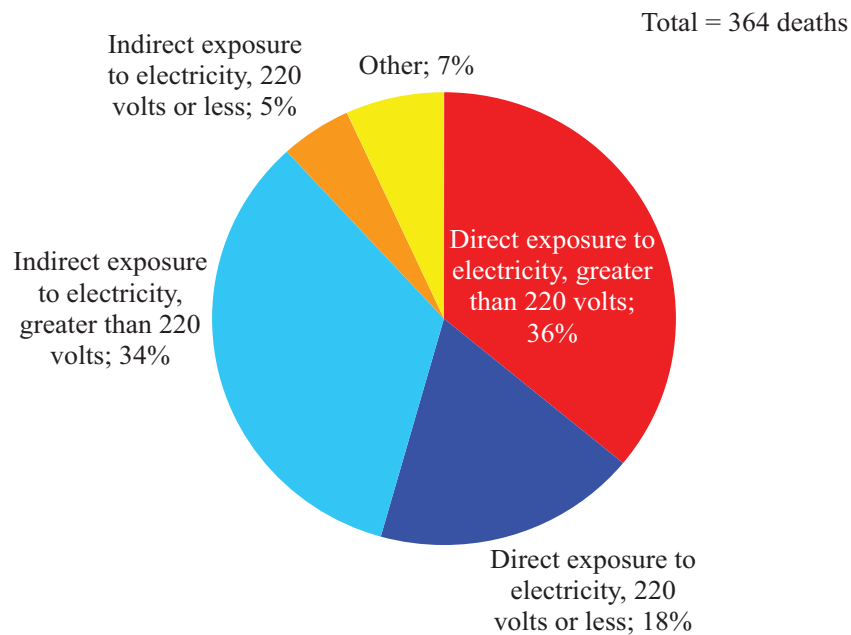
3. Number of electrocutions, by major industry, 2015 (All employment)

Source: U.S. Bureau of Labor Statistics, 2015 Census of Fatal Occupational Injuries. Numbers were from the online CFOI database.

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In terms of cause, 36% of electrocution deaths in construction were caused by direct exposure³ to more than 220 volts of electricity between 2011 and 2015 (chart 4). Another third (34%) of deaths were caused by indirect exposure⁴ to more than 220 volts of electricity. Direct or indirect exposure to electricity of 220 volts or less combined caused 23% of electrocution fatalities.

4. Electrocutions in construction, by major event or exposure, sum of 2011-2015

³Direct exposure: when a worker makes direct contact with a power source, such as touching a live wire or being struck by an electrical arc.

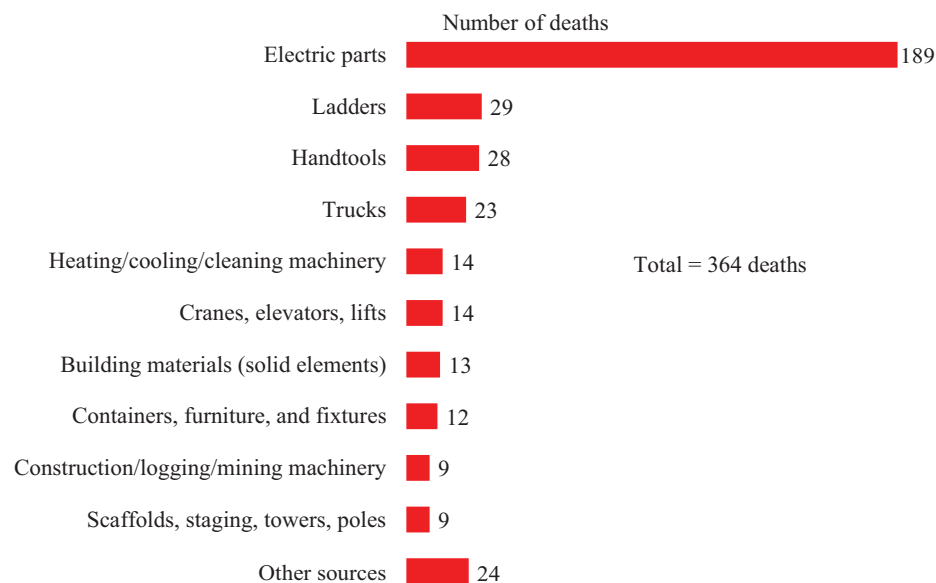
⁴Indirect exposure: typically occurs when an object is unintentionally electrified, such as when a pipe being held by a worker contacts a power line, when a crane touches a power line, or when electricity is transmitted to a worker through a wet surface.

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

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By the primary source of electrocution, electric parts were the leading source of electrocution fatalities in construction between 2011 and 2015, accounting for more than half of electrocution deaths in construction during this time (189 out of 364; chart 5). Ladders were the second most common source of electrocution in construction, causing 29 deaths in these five years.

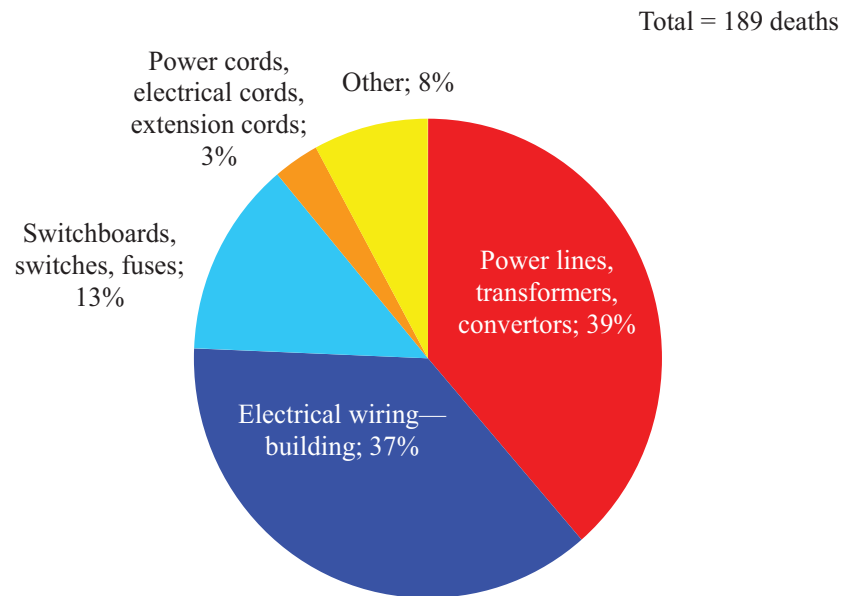
5. Number of electrocutions in construction, by primary source, sum of 2011-2015

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

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Among deaths due to contact with electric parts in construction, 39% were from power lines, transformers, or converters (chart 6). Electrical wiring in buildings was the second-most common source, causing 37% of deaths.

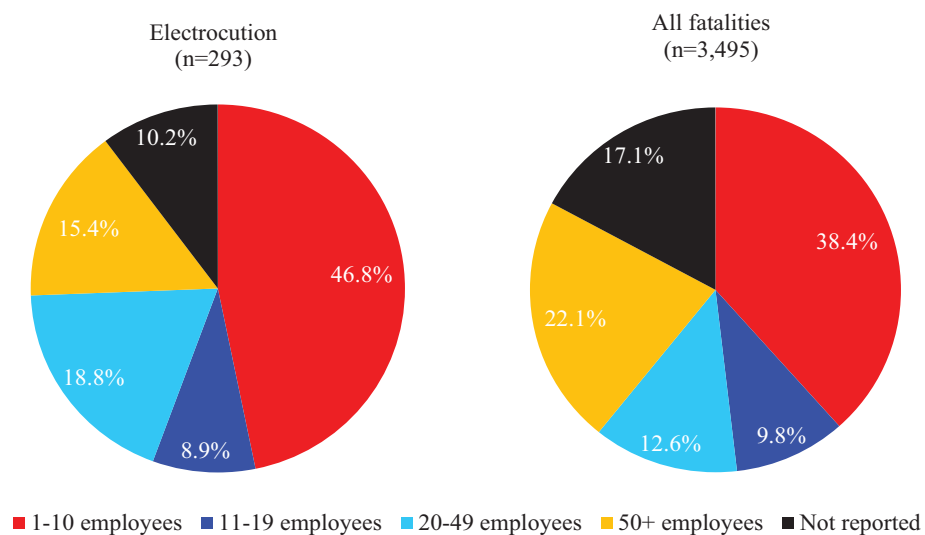
6. Electrocutions caused by electric parts in construction, by primary source, sum of 2011-2015

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

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Electrocution deaths were more likely to occur among small establishments. About 47% of electrocution deaths occurred in establishments with 10 or fewer employees, which is disproportionately high given that 38% of all fatalities occurred in establishments of this size (chart 7). Overall, nearly three out of four (74%) electrocution deaths in construction were from establishments with fewer than 50 employees.

**7. Electrocutions in construction, by establishment size, sum of 2011-2015
(Wage-and-salary workers)**

Note: Self-employed workers were excluded.

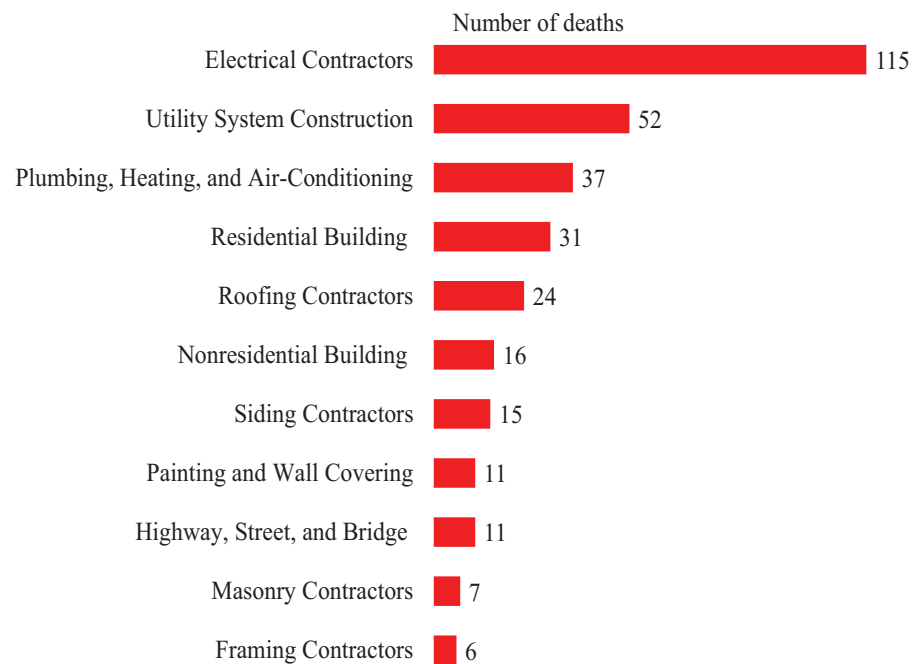
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

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SECTION 2: Electrocutions among Construction Subgroups

By construction subsector, electrical contractors (NAICS 23821) had the highest number of electrocution deaths in construction. From 2011 to 2015, 115 construction workers in this sector were killed by electrocution, nearly one third (32%) of all electrocution deaths in construction over these years (chart 8). Utility system construction workers also suffered a high number of electrocutions, with 52 fatalities during the same period.

8. Number of electrocutions in construction, selected construction subsectors, sum of 2011-2015

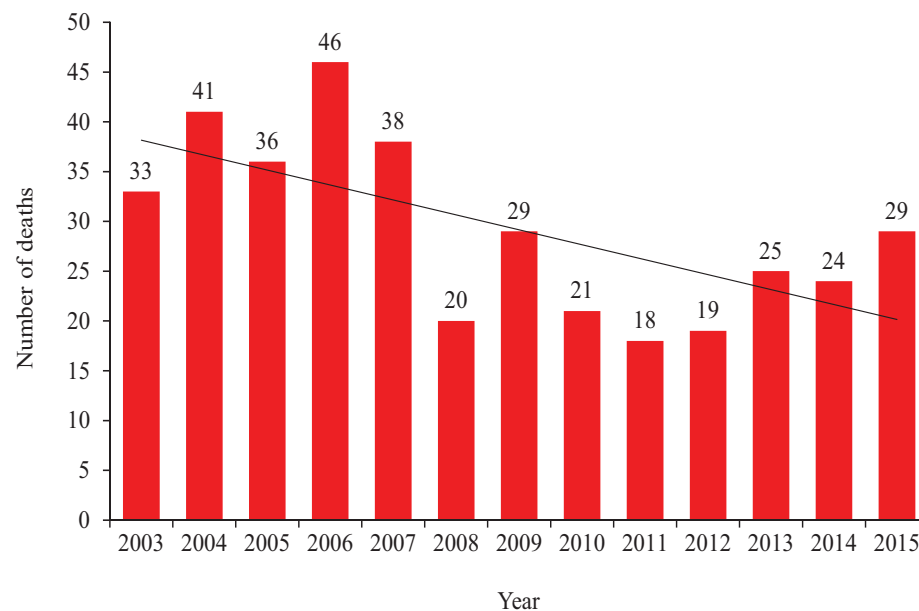


Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

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The number of electrocution deaths among electrical contractors (NAICS 23821) in construction has fluctuated but generally declined over time (see the trend line; chart 9). Fatalities reached a high point in 2006 with 46 electrocutions, and then fell 61% to 18 deaths in 2011, before increasing 61% to 29 deaths in 2015. On average from 2003 to 2015, about 23 electrocution deaths occurred yearly in this subsector.

9. Number of electrocutions in Electrical Contractors (NAICS 23821), 2003-2015

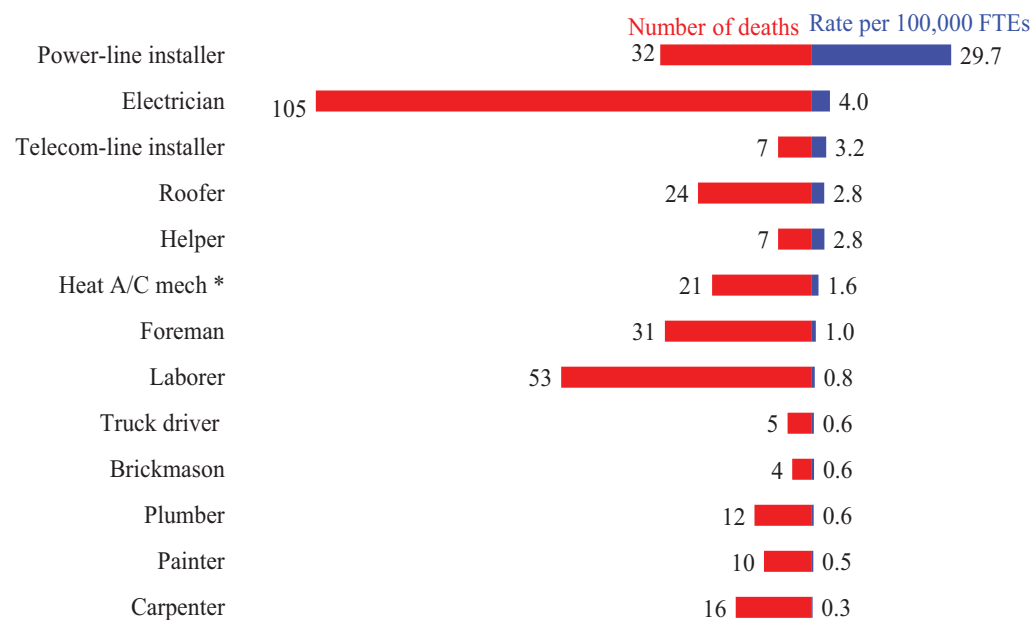
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. The views expressed here do not necessarily reflect the views of the BLS.

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By detailed occupation in construction, 105 electricians died of electrocution from 2011 to 2015, more than in any other occupation (chart 10). However, the risk of electrocution was highest among power-line installers, who had a rate of 29.7 deaths per 100,000 FTEs, nearly forty times that of all construction occupations on average (0.8 deaths per 100,000 FTEs).

10. Number and rate of electrocutions in construction, selected construction occupations, sum of 2011-2015



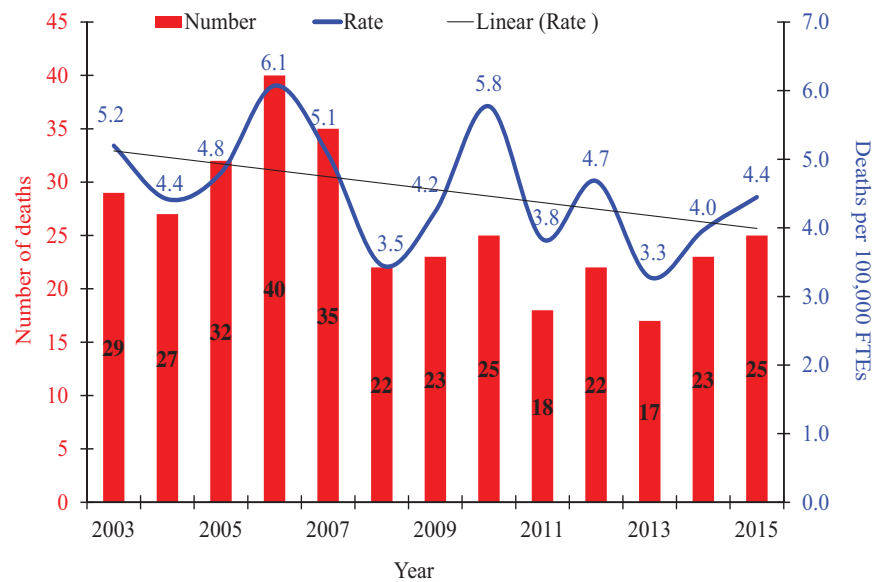
*refers to the Heating and Air Conditioning Mechanics occupation

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

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The number and rate of electrocution deaths among electricians fluctuated over time. However, the rate of electrocution in this occupation has gone down in general, and in 2015 was 17% lower than the 2003 level (chart 11). Between 2011 and 2015, 21 electricians died yearly from electrocution, at an average rate of 4 deaths per 100,000 FTEs.

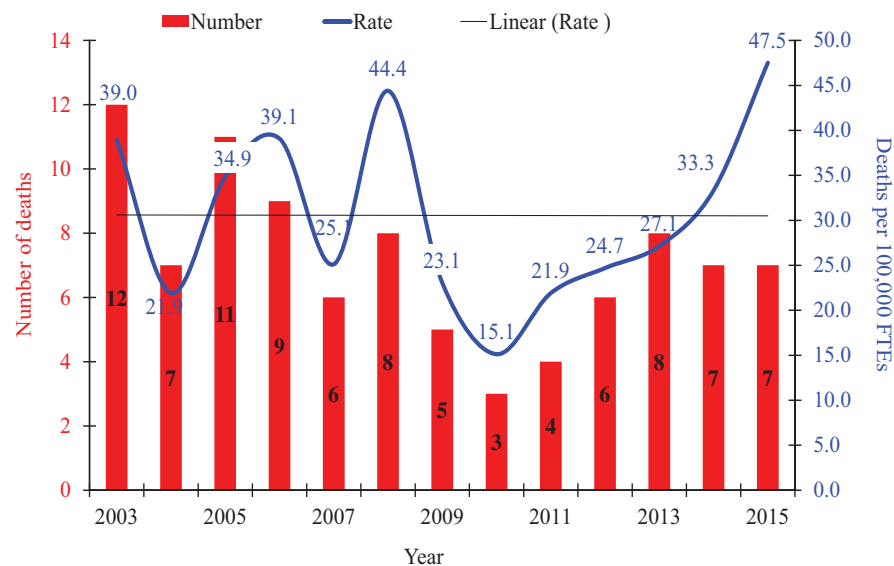
11. Number and rate of electrocutions among electricians, 2003-2015

Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

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From 2003 to 2015, electrocution deaths among power-line installers fluctuated without a clear pattern. The rate was nearly three times lower in 2010 than in 2003 (15.1 versus 39.0), but then more than tripled from 2010 to 2015 (15.1 versus 47.5; chart 12).

12. Number and rate of electrocutions among power-line installers, 2003-2015

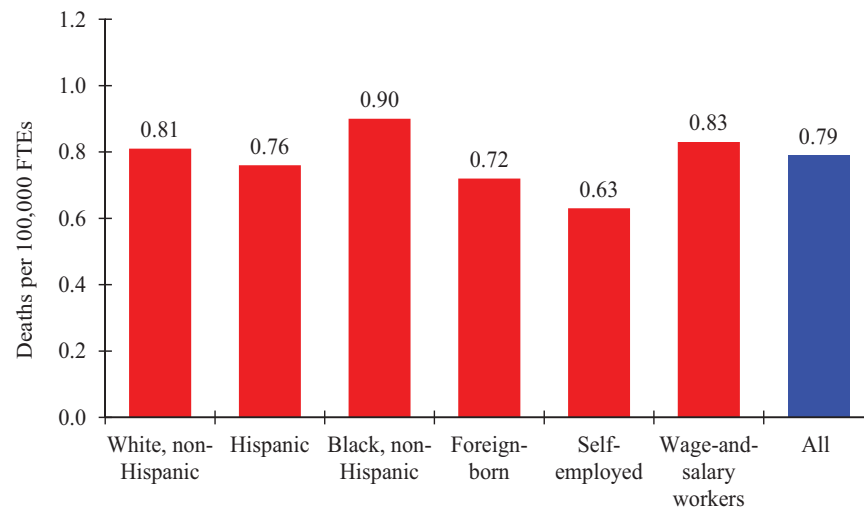
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

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The rate of electrocution deaths in construction varies by worker characteristics. On average from 2011 to 2015, black, non-Hispanic workers had the highest rate of electrocutions of any worker group, with 0.90 deaths per 100,000 FTEs, while self-employed workers had a lower rate than overall construction, at 0.63 deaths per 100,000 FTEs, compared to 0.79 for all construction (chart 13).

13. Rate of electrocutions in construction, selected worker characteristics, average of 2011-2015



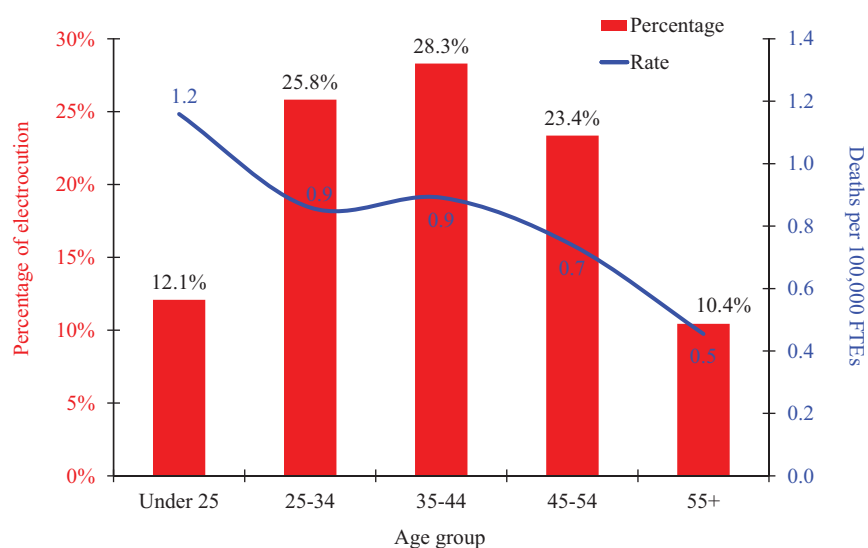
Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

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By age group, middle-aged workers had a higher proportion of electrocution deaths. Between 2011 and 2015, about 28% of workers who died of electrocution were aged 35-44, a larger proportion than for any other age group (chart 14). However, the risk of electrocution decreased by age. Workers less than 25 years old suffered the highest rate of any age group, with 1.2 fatalities per 100,000 FTEs, while workers aged 55 and older had the lowest rate of electrocution, at 0.5 deaths per 100,000 FTEs.

14. Percentage and rate of electrocutions in construction, by age group, average of 2011-2015



Source: Fatal injury data were generated by the CPWR Data Center with restricted access to BLS CFOI micro data. Numbers of FTEs were estimated using the Current Population Survey. Calculations by the authors. The views expressed here do not necessarily reflect the views of the BLS.

SECTION 3: Electrocution Prevention in Construction

Many solutions can be implemented to prevent electrocutions among construction workers. Some of these solutions include personal protective equipment like rubber gloves and non-conductive clothing, engineering controls like surge protection devices, safety measures like regular tool inspection and maintenance, and other precautionary measures like using non-conductive ladders and cover-up equipment (Table 1). The implementation of safety solutions such as the ones presented below can greatly reduce injuries and deaths caused by electrical hazards.

Table 1: Solutions to Prevent Electrocutions

Source	Hazard	Solution
Power line- direct contact	Contact with live wire	<ul style="list-style-type: none"> • Use insulating blankets, cover-up equipment, live-line tools and insulating line hose¹ • Use Building Information Modeling (BIM) for safety planning¹ • Wear personal fall arrest system (PFAS) in case of shocks while working at heights² • Don't use flexible wiring where it may get damaged³
	Contact with voltage while working on de-energized power lines	<ul style="list-style-type: none"> • Verify appropriate transfer switch is installed and in use prior to commencing work¹ • Test whether circuits are de-energized, then ground circuits, before starting work³ • Use temporary protective grounds¹ • Use lock out tag out (LOTO) devices¹
	Contact with underground electric cable	<ul style="list-style-type: none"> • Use geospatial augmented reality system to locate underground cables¹
Power line- indirect contact	Live power line touches ladder in use	<ul style="list-style-type: none"> • Use non-conductive ladders¹
	Live power line touches construction equipment in use	<ul style="list-style-type: none"> • Use overhead powerline proximity warning devices for heavy equipment¹ • Keep equipment a safe distance from uninsulated overhead power lines and service entrance cables²
Lightning	Working outside during a storm	<ul style="list-style-type: none"> • Ring ground¹ • Go inside out of the rain until safe to return to work³
Electric devices	Voltage spike or transfer from electrical device in use	<ul style="list-style-type: none"> • Use surge protection devices (SPD)¹ such as circuit breakers, fuses, ground fault circuit interrupters (GFCIs), and arc-fault circuit interrupters⁴ • Regularly inspect and maintain tools⁴ • Take frayed wires and other damaged electrical parts out of service immediately⁵ • Only use correct size and type of wire³
	Contact with energized conductors	<ul style="list-style-type: none"> • Use proper cover-up equipment installed by trained worker¹
	Use of electrified devices in wet conditions	<ul style="list-style-type: none"> • Use ground fault circuit interrupters (GFCIs)¹ • Avoid working in wet conditions, wearing wet clothes, or standing in water³

Source: see page 18.

Conclusion

Electrocutions are the third leading cause of death among construction workers. Between 2003 and 2015, the number of electrocution deaths in construction decreased by 39% compared to the 16% reduction in construction fatalities, suggesting intervention on construction electrocution is relatively effective. In 2005, OSHA proposed revising the construction standard for electric power transmission and distribution work (29 CFR part 1926, subpart V; OSHA, 2014) and a new construction standard for electrical protective equipment (29 CFR 1926.97; OSHA, 2014). These standards were finalized in 2014. In addition, contractors in electrical transmission and distribution, OSHA, the International Brotherhood of Electrical Workers, and industry trade groups joined forces on a multi-faceted initiative aimed at reducing risk in this trade (ET&D, 2016).

Despite the reduction, 82 construction workers died of electrocutions in 2015, more than the number of electrocution fatalities in every other industry combined. More electrocution deaths were caused by direct or indirect exposure to more than 220 volts of electricity than any other event, and electric parts (power lines, transformers, converters, etc.) were the leading source of electrocution deaths. Compared to all fatalities, a larger portion of electrocution fatalities occurred at establishments with 10 or fewer employees. Electrical contractors had a higher number of electrocution death than any other subsector. By occupation, electricians had the highest number of electrocution deaths, while power-line installers had the highest rate. By age group, middle-aged workers had a higher proportion of electrocution deaths, while workers under 25 years had the highest risk of any age group.

Electrocution deaths are preventable. The solutions table presented in this report includes safety procedures, engineering controls, and other prevention methods that may reduce or eliminate the hazards that lead to electrocutions in construction. Many of these methods can be used separately or together to protect construction workers working around electrical devices, power lines, and other potentially hazardous situations.

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Data Sources

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Table 1 Sources (all accessed September 2017)

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About the CPWR Data Center

The CPWR Data Center is part of CPWR – The Center for Construction Research and Training. CPWR is a 501(c)(3) nonprofit research and training institution created by North America’s Building Trades Unions, and serves as its research arm. CPWR has focused on construction safety and health research since 1990. The Quarterly Data Reports – a series of publications analyzing construction-related data, is part of our ongoing surveillance project funded by the National Institute for Occupational Safety and Health (NIOSH).

Please visit CPWR’s other resources to help reduce construction safety and health hazards:

Construction Solutions <http://www.cpwrconstructionsolutions.org/>

Construction Solutions ROI Calculator <http://www.safecalc.org/>

The Electronic Library of Construction OSH <http://www.elcosh.org/index.php>

Falls Campaign <http://stopconstructionfalls.com/>

Hand Safety <http://choosehandsafety.org/>

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