WHY DO ELECTRICAL FATALITIES OCCUR ON THE JOB? UNDERSTANDING THE HUMAN FACTOR OF A FATALITY

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Abstract – Contact with or exposure to electricity continues to be one of the leading causes of workplace fatalities and injuries in the United States. Between 2011 and 2021, there was a total of 1,201 workplace fatalities involving electricity reported by the Occupational Safety and Health Administration (OSHA), accounting for 6% of all workplace deaths. During this period, 69% of all electrically related fatalities happened in non-electrically related occupations. Further, there has not been a significant decrease in the number of electrical fatalities since 2011. This paper examines each electrical incident that occurred in the United States during this period to find commonalities in fatal electrical incidents, if engineering controls or behavioral changes could have avoided the injury, and the changes that can be made in the workplace and training to reduce the number of electrically related injuries in the United States.

Index Terms — electrocution, electrical shock, electrical burn, electrical injury, overhead power lines, occupation, degree of injury, nature of injury, OSHA.

I. INTRODUCTION

According to the U.S. Energy Information Administration, the United States used a total of 3.93 trillion kilowatt hours of electricity in 2021, which is 13 times higher than electricity use in 1950 [1]. With the increased electricity use and the growth of energy needs from new readily available products, such as energy storage systems and electric vehicle supply equipment, the potential of workers coming in contact with electricity is greatly increasing.

The authors have worked with the Electrical Safety Foundation International to compile data related to workplace electrical incidents to understand the causes of workplace electrical fatalities. The compiled data comes from two sources, the Bureau of Labor Statistics (BLS) and the Occupational Safety and Health Administration (OSHA). Data from the Bureau of Labor Statistics, specifically the Injuries, Illnesses, and Fatalities (IIF) program, provides data for fatal and nonfatal events. The Census of Fatal Occupational Injuries (CFOI) "provides a comprehensive count of all workplace injuries" [2]. While the BLS and CFOI provide a complete count of injuries, it does not provide context of why the injury occurred, nor does it provide a narrative of the events leading to the injury. This information is available in OSHA Fatality and Catastrophe Investigation Summaries (OSHA 170 form). The investigation summaries from OSHA 170 form provide greater detail on the actions that lead to the electrical incident. With information from OSHA 170 form, the authors were able to create a database cataloging the cause of the electrical fatality, the occupation and industry involved, and were able to assign a human factor to the workplace death based on the investigation narrative provided in the investigation summary. OSHA 170 form is only made available to the public once they "undergo a process for screening personal information and adding keywords," which may result in a delay between when the accident occurred and when the data is made available and results in a difference in the number of incidents when compared to the complete number provided by the BLS [3].

TABLE 1
ELECTRICAL OCCUPATIONS

Electrical and electronic engineers
Electrical and electronic equipment assemblers
Electrical and electronic technicians
Electric power installers and repairers
Electricians
Electricians' apprentices
Electronic repairers, communications, and industrial equipment
Supervisors in above fields

This paper focuses on electrical fatalities that were reported to OSHA and the BLS between 2011 and 2021. To get a better understanding of the causes of electrical fatalities in the workplace, the authors separated workers into two different categories; those who work in electrical occupations and thus are more likely to have a general understanding of the workplace safety standards when working around electricity, listed in Table 1, and non-electrical workers whose occupation does not regularly expose the worker to potentially dangerous electrical situations. For those cases where the occupation was recorded as "unknown" or "not listed," the authors reviewed the investigation summary to find evidence of the worker's occupation and adjusted the report if possible. A total of 70 reports had the occupation listed as "occupation not reported" after the authors' edits. Additionally, relevant cases with the occupations of "groundskeepers and gardeners, except farm" and "chainsaw operators" were combined into "tree trimming occupations" when the worker was completing a tree trimming task when the fatality occurred.

II. THE STATE OF ELECTRICAL FATALITIES

Contact with or exposure to electricity continues to be one of the leading causes of workplace fatalities in the United States.

Between 2011 and 2021, there was a total of 18,644 workplace fatalities reported to OSHA. Electrical fatalities accounted for 1,201, or 6% of these fatalities. Figure 1 shows workplace and electrical fatalities over time and shows a slight decrease in the total amount of electrical fatalities over the years. From 2011 to 2021, there was a 2% drop in the number of electrically related deaths in the United States, compared to a 5% increase in the total number of workplace fatalities.

FIGURE 1 Workplace fatalities and electrical workplace fatalities reported in OSHA 170 form, 2011 - 2021

Figure 2 shows the rate of electrical incidents and all workplace fatalities per 100,000 workers. All workplace fatalities had an average number of 3.56 fatalities per 100,000 workers, and the average rate of change for the fatalities was 0.3%. Electrical fatalities had an average of 0.11 fatalities per 100,000 workers and an average rate of change of -3%. The effects of the COVID-19 pandemic on the working conditions in the United States may have affected the total number of workplace-related electrical fatalities. BLS fatality rates for all workplace fatalities are only available up until 2020.

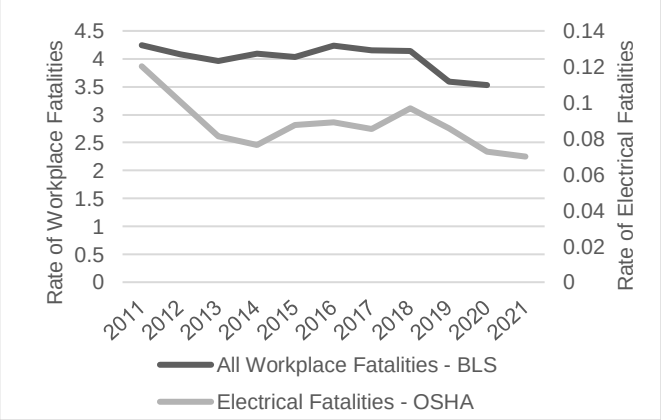

FIGURE 2 Rate of workplace and electrical fatalities per 100,000 workers, 2011 - 2021

Figure 3 shows that between 2019 and 2020, there was a 6% drop in the total number of hours worked in the United States and a 23% drop in the total number of electrical fatalities. Between 2020 and 2021, there was a 4% increase in the number of hours worked and a 4% increase in the number of electrical fatalities. In the years before the COVID-19 pandemic (2011 – 2019), there was an average of 2% growth year-over-year in the total hours worked in the United States, and there was an average growth of 0.1% in electrical fatalities. The significant drop in electrical fatalities between 2019 and 2020 may have been caused by the decrease in the number of employees in goods-producing industries between 2019 and 2021. During April 2020, when 45 United States state governments issued a "stay-at-home" order, there were 18.5 million employees in goods-producing industries, an 11.8% drop from the same period in 2019. By April 2021, the number of goods-producing employees increased to 20.2 million employees, down 4% from 2019 numbers.

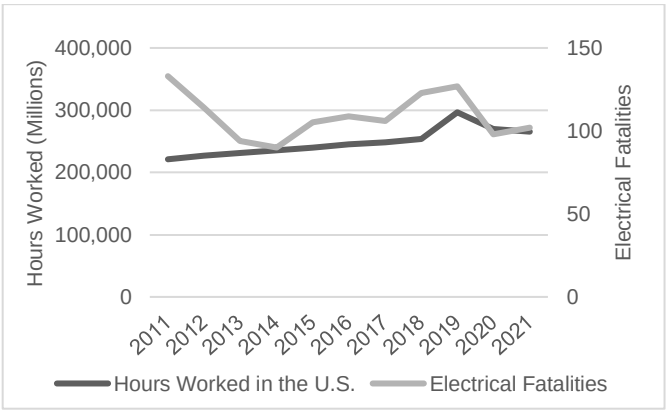

FIGURE 3 total hours worked in the United States and rate of electrical fatalities, 2011 - 2021

III. OCCUPATIONS INVOLVED IN ELECTRICAL FATALITIES

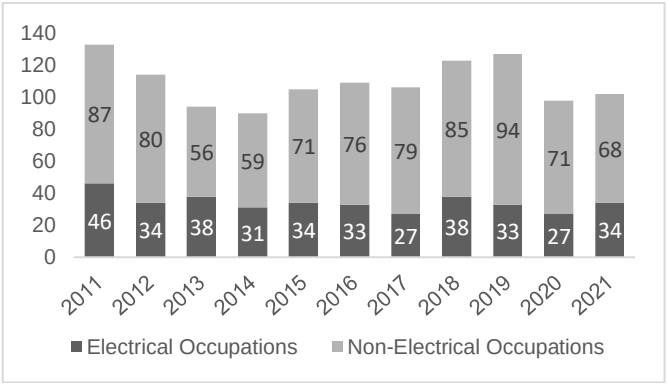

FIGURE 4 Electrical fatalities by occupation type, 2011 - 2021

OSHA 170 form categorizes occupations into one of 573 recognized occupations, including occupations listed as "not applicable," "occupation not reported," or "occupation not listed." A total of 118 occupations were involved in electrical fatalities between 2011 and 2021. Eight electrical occupation fatalities accounted for 375 (31%) of all the fatalities, while non-electrical occupations accounted for the remaining 826 (69%) of the fatalities. Figure 4 lists the number of electrical occupation fatalities and the number of non-electrical fatalities over the years. Non-electrical occupations fatalities decreased by an average of 1.2% year-over-year, while electrical occupations fatalities decreased by an average of 0.89%.

Ten occupations account for 60% of all electrical fatalities in the workplace, with three being electrical occupations. Electricians account for the highest percentage of electrical fatalities (15.15%), followed by laborers, except construction (10.07%), construction laborers (8.99%), electrical power installers and repairers (8.49%), tree trimming occupations (5.33%), electricians' apprentices (3.25%), heating, air conditioning, and refrigeration mechanics (2.83%), painters, construction and maintenance (2.75%), roofers (2.16%), and machinery maintenance occupations (1.92%). Table 2 lists all occupations with ten or more electrical fatalities between 2011 and 2021. Annex A lists all occupations that had an electrical fatality between 2011 and 2021.

TABLE 2
OCCUPATIONS WITH 10 OR MORE ELECTRICAL FATALITIES, 2011 - 2021

Occupation	Fatalities
Electricians	182
Laborers, except construction	121
Construction laborers	108
Electrical power installers and repairers	102
Occupations not reported	70
Tree trimming occupations	64
Electricians' apprentices	39
Heating, air conditioning, and refrigeration mechanics	34
Painters, construction and maintenance	33
Roofers	26
Machinery maintenance occupations	23
Truck drivers, heavy	23
Electrical and electronic engineers	21
Telecomm: line installers and repairers	21
Installers and repairers	20
Carpenters	17
Technicians, not elsewhere classified	13
Electrical and electronic technicians	13
Construction trades, not elsewhere classified	12
Helpers, construction trades	11
Groundskeepers and gardeners, except farm	11
Farm workers	11
Welders and cutters	11
Plumbers, pipefitters and steamfitter apprentices	10

The vast majority (97%) of electrical fatalities occurred in privately owned workplaces. Local government made up 2% of the fatalities, while both federal and state government accounted for 0.5% each. Workers who were a part of a union accounted for 13% of all workplace electrical fatalities, 27% for electrical occupations, and 7% for non-electrical occupations. Between 2011 and 2021, an average of 12% of the United States workforce were members of a union.

IV. ACTIONS LEADING TO ELECTRICAL FATALITIES

To understand why electrical fatalities are occurring in specific occupations, the authors reviewed the narrative provided in the OSHA 170 form to find commonalties in workers' actions. The authors categorized the cause of electrical fatalities into the following categories. Each incident may have more than one human factor leading to the injury:

a) *Working on or near energized conductors / energized parts*: The fatal injury occurred due to contact with energized conductors or equipment. This occurred from the equipment being worked on or nearby equipment or wires, excluding overhead power lines.
b) *Contact with overhead power lines*: The fatal injury occurred from contact with overhead power lines. This excludes contact with other energized equipment or wires. This also includes arcing events caused by overhead power lines.
c) *Lockout / tagout procedure failure or safety controls removed:* The fatal injury narrative mentions the removal of safety devices or a failure of a lockout / tagout procedure.
d) *Lack of personal protection equipment (PPE):* The narrative mentions the lack of personal protective equipment when the fatal injury occurred.
e) *Electrical fire:* The fatal injury occurred due to an electrical fire that ignited due to the type of work the worker was completing.

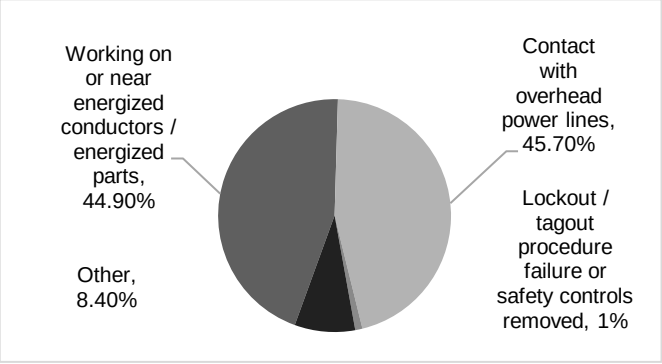

FIGURE 5 Cause of electrical fatality, all workers, 2011 – 2021

Contact with overhead power lines is the leading cause of electrical fatalities for all workers, accounting for 45.7% of all fatalities. Working on or near energized conductors / energized parts is the second leading cause with 44.9% of all fatalities. Lockout / tagout procedure failure or safety devices removed accounted for 1%. The remaining fatalities were caused by a combination of factors, including 4.2% of fatalities caused by "lockout / tagout failure or safety devices removed" and "working on or near energized conductors / energized parts," and 1.5% of fatalities were caused by "lack of PPE" and "working on or near energized conductors / energized parts." Fatalities caused by a lack of PPE or electrical fires accounted for the remaining 2.7%. According to OSHA reports, 44% of workers who died on the job were completing a task that they were regularly assigned to do. The authors reviewed the narrative of each event to see if the death could have been prevented by either engineering controls or by behavioral changes.

A. Electrical Occupations (375 Fatalities)

Of the 375 electrical occupation electrical fatalities, 75% were caused by working on or near energized conductors / energized parts. Contact with overhead power lines accounted for 19% of

all fatalities, while lockout / tagout procedure failure or safety devices removed accounted for 3%. Two or more factors accounted for 4% of fatalities. A total of 224, or 81%, of fatalities, could have been prevented with additional behavioral changes, safety devices, or engineering controls. Workers who were completing their regularly assigned task when the fatality occurred accounted for 49% of all electrical occupation fatalities. Two fatalities (0.5%) were directly attributed to a lack of training.

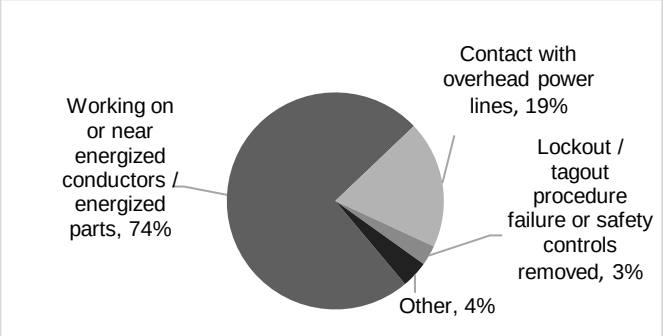

FIGURE 5 Cause of electrical fatality, electrical occupations, 2011 – 2021

B. Non-Electrical Occupations (824 Fatalities)

Contact with overhead power lines is the leading cause of non-electrical workers' electrical fatalities, accounting for 57% of the total deaths. Working on or near energized conductors / energized parts was reported in 40% of fatalities, followed by two or more factors at 2%, and lockout / tagout procedure failure or safety controls removed at 1%. Two hundred forty incidents, 29% of total fatalities, could have been prevented. Many non-electrical workers were completing a task they normally were not assigned to do. Only 42% of the fatalities occurred when a worker was completing a task they were normally assigned to do. Eight percent (0.9%) of fatalities were directly attributed to a lack of training.

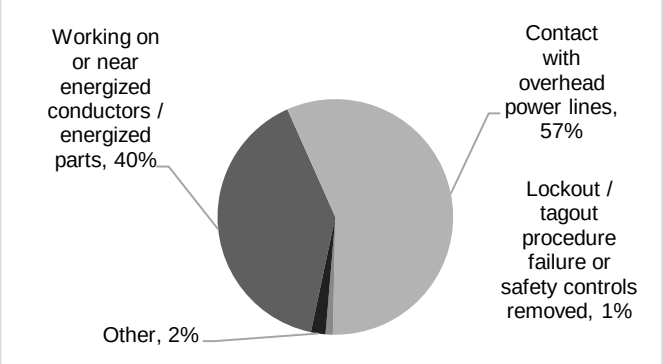

FIGURE 6 Cause of electrical fatality, non-electrical occupations, 2011 – 2021

V. HOW TO PREVENT ELECTRICAL FATALITIES

In addition to the action that led to the electrical fatality, the narrative provided insight to the actual cause of the electrical fatality. The authors categorized the source of the fatality into the following categories:

a) *Overhead power line contact (583 events)*: Direct or indirect contact with overhead power lines, including arcing events from overhead power lines. Categorized as a "non-preventable" death.
b) *Unexpected contact with energy (385 events)*: Worker came in direct or indirect contact with energized equipment, devices, or parts, excluding overhead power lines and arcing events.
c) *Working on energized parts (55 events)*: Worker specifically decided to work on energized parts.
d) *Ground Faults (46 events):* A ground fault was specifically mentioned as a cause of the fatality.
e) *Damaged wiring, parts, or equipment (41 events):* Worker was working on or with damaged wiring, parts, or equipment that specifically led to the fatality.
f) *Troubleshooting / testing (29 events):* Worker was conducting either troubleshooting or testing when the fatality occurred.
g) *Worker mistake (21 events):* Worker made a mistake by either not following proper procedure, not wearing proper PPE, or using incorrect tools / equipment that led to the fatality.
h) *Contact with underground power lines (11 events):* Worker made fatal contact with underground power lines
i) *Arc flash (10 events):* Fatality was specifically caused by either an arc flash or arc blast.
j) *Lockout / tagout failure (9 events):* Fatality occurred due to not following proper lockout / tagout procedures.
k) *Improper installation (4 events):* Fatality occurred due to improperly installed parts or equipment.
l) *Backfeed (2 events):* Electrical backfeeding was the direct cause of the fatality.
m) *Defective or failed equipment or parts (1 event):* Fatality was specifically caused by a defective or failed part or equipment.

The top five sources of electrical fatalities are overhead power line contact (48.5%), unexpected contact with electricity (32%), working on energized parts (4.6%), ground faults (3.8%), and damaged wiring or equipment (3.4%), accounted for 92.4% of all electrical fatalities.

The authors also reviewed the narrative of the event to verify if actions could have been taken to prevent the fatality. Fatalities were considered preventable if safety devices or engineering controls could have been implemented to notify the worker of the potential hazards around them. For example, in the cases categorized as preventable and the source was "unexpected contact with energy," the worker unexpectedly came in contact with energy when working around energized sources. Voltage detectors could have prevented the injury by notifying the worker of energized parts around the equipment they were working on. Events caused by weather, such as wind blowing a ladder into an overhead power line, cases where the investigators were unable to fully identify the source of electrical contact, and all overhead power line contact events were considered as not preventable due to lack of information regarding why the contact with overhead power lines occurred other than human error or

not identifying the overhead hazards.

The authors also included whether the worker involved in the electrical fatality was part of a union. Union status was included because, according to the U.S. Department of Labor, “enforcement of safety and health laws is stronger at unionized workplaces” and “a recent study of National Labor Relations Board and OSHA data shows that union certification has positive effects on the rate of OSHA inspections, the share of inspections carried out in the presence of a union representative, violations cited, and penalties assessed” [4].

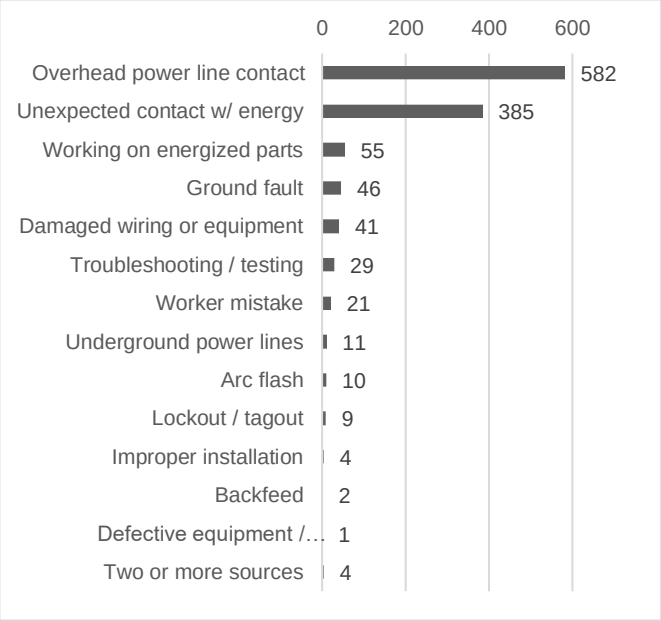

FIGURE 7: Source of electrical fatality, all workers, 2011 - 2021

A. Overhead Power Line Contact (583 events)

Contact with overhead power lines was the leading source of electrical fatalities on the job. Non-electrical workers made up 81.6% of the overhead power line contact fatalities. Electrical power installers and repairers (13.04%), construction laborers (11.66%), laborers except construction (11.66%), tree trimming occupations (10.63%), painters, construction and maintenance (4.8%), truck drivers, heavy (3.77%), roofers (3.6%), electricians (3.09%), telecomm: line installers and repairers (3.09%), and carpenters (1.89%), all had ten or more fatalities caused by overhead power line contact between 2011 and 2021 and made up 67.24% of the fatalities. Eighty-eight percent of the fatalities were workers who were not part of a union.

B. Unexpected Contact with Energy (385 events)

Non-electrical workers accounted for 57.66% of unexpected contact with energy fatalities. Electricians accounted for the occupation with the most unexpected contact with energy at 25.19% of the fatalities. Laborers except construction (8.57%), construction laborers (5.71%), electricians’ apprentices (5.45%), heating, air conditioning, and refrigeration mechanics (5.19%), electrical power installers and repairers (4.42%), and electrical and electronics engineers (3.12%) all had ten or more fatalities and accounted for 60.78% of the deaths. Sixty-two percent of the fatalities could have been prevented by safety devices. Nonunion workers accounted for 85.45% of all the fatalities.

C. Working on Energized Parts (55 events)

Electrical workers accounted for most fatalities (65.45%) caused by working on energized parts. Electricians alone accounted for 47.27% of all working on energized parts fatalities. Heating, air conditioning, and refrigeration mechanics (5.45%), laborers, except construction (5.45%), construction laborers (5.45%), electricians’ apprentices (5.45%), electrical and electronics technicians (3.64%), machinery maintenance occupations (3.64%), and electrical and electronics engineers (3.64%) accounted for 80% of the fatalities. Ninety-eight percent of fatalities could have been prevented, and 78.18% of fatalities were nonunion workers.

D. Ground Faults (46 events)

Non-electrical workers accounted for 86.96% of all fatalities caused by ground faults. Laborers, except construction accounted for 19.57% of fatalities caused by ground faults. Other occupations with ground fault fatalities included construction laborers (8.70%), plumber, pipefitter and steamfitter apprentices (6.52%), plumbers, pipefitters and steamfitters (6.52%), electricians (6.52%), installers and repairers (6.52%), machinery maintenance occupations (4.35%), carpenters (4.35%), electricians’ apprentices (4.35%), farm workers (4.35%), and heating, air conditioning, and refrigeration mechanics (4.35%). Most of the fatalities, 98%, could have been prevented with proper ground fault protection, and 97.83% of fatalities were nonunion workers.

E. Damaged Wiring or Equipment (41 events)

Non-electrical workers accounted for 82.93% of all damaged wiring or equipment fatalities. Two occupations accounted for 26.83% of the fatalities, electricians (14.63%) and laborers, except construction (12.20%). Other occupations involved included construction laborers (9.76%), and heating, air conditioning, and refrigeration mechanics (7.32%), drywall installers (4.88%), plumbers, pipefitter, and steamfitter apprentices (4.88%), groundskeepers and gardeners, except farm (4.88%), and machinery maintenance occupations (4.88%). All fatalities could have been prevented by safety devices, and 95.12% of the fatalities were with nonunion workers.

F. All Other Sources (87 events)

Electrical occupations made up the majority of the fatalities caused by all other sources (61.54%). Electricians accounted for 35.16% of the fatalities. Electrical power installers and repairers (8.79%), electricians’ apprentices (8.79%), construction laborers (7.69%), and installers and repairers (4.40%) were the leading occupations with fatalities caused by all other sources. A total of 94.51% of the fatalities could have been prevented by safety devices, and 81.32% of fatalities occurred to nonunion workers.

VI. CONCLUSION

Contact with electricity continues to be a leading cause of fatalities in the workplace, accounting for 6% of all fatalities.

Over the years, the rate of electrical fatalities has only dropped an average of 3% every year. While this is better than the rate of change seen in all workplace fatalities, which experienced an average of 0.3% growth every year, many of the workplace electrical fatalities can be prevented with proper safety devices or engineering controls.

Though non-electrical occupations continue to be the majority of all workplace electrical fatalities, accounting for 69% of the fatalities, non-electrical occupation fatalities have fallen at a greater rate than electrical occupation electrical fatalities. Non-electrical occupation fatalities dropped an average of 1.2% per year compared to 0.89% for electrical occupations.

Two actions accounted for 90.6% of all electrical fatalities. Contact with overhead power lines accounted for 45.7% of the fatalities and mostly effected non-electrical workers (57% of the fatalities), while working on or near energized parts accounted for 44.9% of the fatalities and mostly affected electrical occupations (75% of the fatalities). Both hazards can be avoided by workers being alert and recognizing the potential hazards around them on the worksite and by staying away from areas and equipment they are not trained to work on or nearby.

There were five sources of contact with electricity that accounted for 92% of fatalities, overhead power lines, unexpected contact with electricity, working on energized parts, ground faults, and damaged wiring. All sources, with the exception of working on energized parts, affected non-electrical workers more than electrical workers. In instances where the worker specifically decided to work on energized parts, 65.45% of the fatalities occurred in electrical occupations.

As many as 39% of electrical fatalities could have been prevented by safety devices, such as voltage detectors or permanently installed electrical safety devices, or engineering controls. These preventable fatalities mostly occurred from unexpected contact with energy, working on energized parts, ground faults, and damaged wiring or equipment. Based on the narrative of the fatalities, voltage detectors or sensors could have notified the worker of the dangers around them. By simply using readily available ground fault circuit interrupters, especially portable versions of the devices, a total of 7% of all fatalities could have been prevented.

Most of the electrical fatalities that occurred between 2011 and 2021 came from sources that could directly be seen or could be detected with safety devices. Overhead power line fatalities could be prevented by educating all workers on the dangers of overhead power line contact and reminding workers to always be aware of their surroundings, and to always look up in all ways when working in any job site. Unexpected contact with electricity could be prevented by reminding qualified workers to always test before they touch or to always check to see if parts are energized before work is completed. The most common causes of fatalities are the most avoidable, and all workers, not just electrical workers, should be trained how to avoid electrical hazards. Nonelectrical workers should be trained how to understand normal operating conditions and recognize damaged wiring. Safety devices, such as permanently installed safety devices, could also prevent injuries by notifying workers of present voltage.

VII. REFERENCES

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VIII. VITAE

Daniel Majano is the Program Manager at the Electrical Safety Foundation International (ESFI). Since 2014, Mr. Majano has developed, and managed programs dedicated to the advancement of electrical safety to prevent electrically related injuries, deaths, and property damage in both workplace and residential settings. Mr. Majano has led ESFI’s effort to compile workplace and residential electrical safety data to guide ESFI’s awareness materials. Mr. Majano is a graduate of George Mason University.

Brett Brenner is the President of the Electrical Safety Foundation International (ESFI). Over the past 16 years, Mr. Brenner has developed aggressive marketing and awareness campaigns to advance electrical safety. Such successes have established ESFI as the primary source for unbiased electrical safety information to reduce electrically related deaths, injuries, and property losses. Mr. Brenner is a graduate of Radford University and is active in many professional organizations promoting public safety, including the National Fire Protection Association’s Educational Messages Advisory Council and the Underwriter’s Laboratories Consumer Advisory Council.

ANNEX A: ALL OCCUPATIONS INVOLVED IN ELECTRICAL FATALITIES

Occupation	Fatalities	Occupation	Fatalities
Electricians	182	Helpers, mechanics and repairers	4
Laborers, except construction	121	Elevator installers and repairers	4
Construction laborers	108	Truck Driver: Heavy/Tractor-Trailer	4
Electrical power installers and repairers	102	Crane and Tower Operators	4
Occupation not reported	70	Equipment Operator: Heavy	4
Tree trimming occupations	64	Machine operators, not specified	4
Electricians' apprentices	39	Roof Repair: Sheet Metal	3
Heating, air conditioning, and refrig. mechanics	34	Paving, surfacing and tamping equipment operators	3
Painters, construction and maintenance	33	Telephone line installers and repairers	3
Roofers	26	Drywall installers	3
Machinery maintenance occupations	23	Production helpers	3
Truck drivers, heavy	23	Water and sewage treatment plant operators	3
Electrical and electronic engineers	21	Supervisors, n.e.c.	3
Telecomm: Line Installers And Repairers	21	Managers and administrators, n.e.c	3
Installers And Repairers	20	Brickmasons and stonemasons	3
Carpenters	17	Agriculture and forestry teachers	3
Technicians, n.e.c.	13	Supervisors, related agricultural occupations	2
Electrical and electronic technicians	13	Insulation Workers	2
Construction trades, n.e.c.	12	Horticultural specialty farmers	2
Helpers, construction trades	11	Not specified mechanics and repairers	2
Groundskeepers and gardeners, except farm	11	Freight, stock and material handlers, n.e.c.	2
Farm workers	11	Communications equipment operators, n.e.c.	2
Welders and cutters	11	Drilling and boring machine operators	2
Plumber, pipefitter and steamfiter apprentices	10	Aerial Lift Operator	2
Supervisors; electricians & power transm. install.	9	Fabricating machine operators, n.e.c.	2
Janitors and cleaners	7	Structural Iron /& Steel Worker	2
Timber cutting and logging occupations	6	Forestry workers, except logging	2
Misc. electrical & electronic equipment repairers	5	Supervisors and proprietors, sales occupations	2
Plumbers, pipefitters and steamfitters	5	Managers, farms, except horticultural	2
Electrical and electronic equipment assemblers	5	Supervisors, farm workers	1
Drillers, oil well	5	Chief exec's & gen'l administrators, public admin.	1
Concrete and terrazzo finishers	5	Surveyors and mapping scientists	1
Roof Repair: Shingle	5	Hand painting, coating and decorating occupations	1
Farmers, except horticultural	5	Sheet metal worker apprentices	1
Assemblers	5	Drillers, earth	1
Telecomm: Equipment Install/Repair, Not Line Installer	4	Bartenders	1
Electronic repairers, communica. & indus. equip.	4	Mechanical engineering technicians	1
Agricultural and food scientists	4	Machinist apprentices	1
Mechanical engineers	1	Supervisors, forestry and logging workers	1

Sales representatives, mining, mfg., & wholesale	1	Driver-sales workers	1
Hazardous Materials Removal Worker	1	Supervisors, production occupations	1
Structural metal workers	1	Highway Maintenance Worker	1
Health aides, except nursing	1	Supervisors; brickmasons, stonemasons, tilesetters	1
Engineering technicians, n.e.c.	1	Printing machine operators	1
Boilermakers	1	Surveying and mapping technicians	1
Furnace, kiln and oven operators	1	Production coordinators	1
Operations & systems researchers and analysts	1	Designers	1
Biological technicians	1	Hoist and winch operators	1
Order clerks	1	Buyers, wholesale & retail trade except farm prod.	1
Diver	1	Railroad conductors and yardmasters	1
Aircraft mechanics, excluding engine	1	Garbage collectors	1
Management related occupations, n.e.c.	1	Earth, environmental & marine science teachers	1
Airplane pilots and navigators	1	Cooks, except short order	1
Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	1	Industrial machinery repairers	1
Pest control occupations	1	Truck drivers, light	1
Adjusters and calibrators	1	Business, commerce and marketing teachers	1
Pipelayer	1	Roofers: Helpers	1
Elevator operators	1	Machinists	1
Plasterers	1	Maids and housemen	1