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A Descriptive Analysis of Telecommunication Construction Fatalities: 1984-2020

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Abstract: ***This descriptive quantitative study examined the difference in the fatality rates of telecommunication construction workers before and after the fall protection equipment (PPE) mandates established by OSHA in 1994. The purpose of this study was to initially explore if there was any significant difference in fatalities before and after the OSHA mandate. The researchers examined OSHA records of all fatalities in telecommunication construction from 1984 to 2020. A Mann-Whitney U test was conducted to determine the difference in the number of telecommunication tower fatalities. The study also used the theoretical framework of protection motivation theory (PMT). The results of the study showed that while there was not a significant difference between the two periods examined, there is still cause for concern among telecommunication construction workers and industry stakeholders regarding safety, the use of PPE, and the execution of fieldwork in telecommunication construction.***

Keywords: Health & Safety, safety, hazards, accident, workplace safety, personal fall protection, rigging, cellular, telecommunication construction, occupational hazard, telecommunication industry

1. Introduction

The telecommunications industry is considered a high-risk occupation as telecommunication technicians work at dangerous heights. Technicians work on cell phone towers, broadcast towers, and various other structures. These structures may range from 100 to well over a thousand feet (U. S. Department of Labor, n. d.). This distinction sets them apart from most residential or commercial construction workers. In such an environment of extreme heights, a personal fall arrest system (PFAS) is mandatory (OSHA 29 CFR §1926.502 (d)).

The Occupational Safety and Health Administration (OSHA) categorizes telecommunication construction workers as a specialized classification of general construction workers. When there is an accident or fatality, citations to a telecommunications company could include citations from OSHA's telecommunications standards, standards in general industry, construction, standards within the telecommunications industry from the National Association of Tower Erectors (NATE) and the American National Standards Institute (ANSI), and/or the Telecommunication Industry Association (TIA). While there is a plethora of literature worldwide regarding the construction industry spanning decades (e. g., Abdelhamid & Everett, 2000; Al-Bayati & York, 2018; Caponecchia & Sheils, 2011; Chi et al., 2005; Ghani et al., 2008; Meng & Chan, 2021; Ringen et al., 2018; Schwatka & Rosecrance, 2016), very little is known of this specialized set of construction workers in telecommunications, specifically regarding fatalities within this population. To understand the fatalities within the industry, one must first examine the existing data. Understanding the frequency, causes, and contributing factors of fatalities in this industry can offer researchers and stakeholders deeper insights that lead to such accidents and what workers and companies can do more efficiently to correct problems and save lives.

1.2 Explore the Importance of the Problem

To understand the fatalities within the industry, one must first examine the existing data. Understanding the frequency, causes, and contributory factors regarding fatalities in this industry may provide researchers and stakeholders with a better understanding of the factors that lead to such accidents and what workers and companies can do more efficiently to correct problems and save lives.

1.3 Describe Relevant Scholarship

Theory: Risk-Taking and Perception

There are many definitions and theories about risk. For example, Hertz and Thomas (1983) defined risk as a chance of loss or injury, Fishhoff et al. (1981) defined risk as a threat to health or life, and Channing (2014) defined risk as the likelihood that harm will occur. Regardless of the definition, a cursory review of OSHA fatality summaries from 1984 to 2020 reveals that causes of fatalities are largely attributable primarily to, in large part, risky behaviors on the part of the worker. As the nature of this study is descriptive, no one theory acts as an underpinning for this research, but among the abundance of information, it is important to understand a few of the foremost theories regarding workplace perception and risk.

Numerous theoretical foundations exist about risk behaviors, workplace accidents, and fatalities. Arguably, one of the first models to address perception and risk originated with Hale and Hale (1970), in which researchers identified the concept of perception in the workplace. A worker's perception results from the worker's expectations, immediately available information, and the process that influences both aspects. Additionally, other variables such as training, skill set, experience, goals, expectations, and task completion also influence workers' choices (Hale & Hale, 1970). Theoretically, a worker will advance a course of action based on this information and other factors, such as the environment, to perform their duties safely (Sawacha et al., 1999).

As one's perception may lead to subsequent actions, Wilde's (1982) homeostasis theory regarding risky behaviors states that four variables determine risk levels: benefits of risky behavior options, costs of cautious behavior options, benefits of cautious behavior options, and costs of risky behavior options. Wilde (1982) stated that the first two benefits of risky behavior options, costs of cautious behavior options, increase the target level of risk, while the latter two, benefits of cautious behavior options and costs of risky behavior options, decrease the target level of risk. Additionally, as put forth by Näätänen & Summala (1974), the zero-risk theory states that perception, motivation, and experimental forces that cause people to situations as "no-risk" guide people's actions.

It is reasonable to assume that the more experience one has in any job, including a high-risk work environment such as telecommunications construction, the more likely workers are to misjudge potential hazards as either inconsequential or less hazardous than they genuinely are due to repeated execution of job duties. Such attitudes may influence workers' safety control measures (Zimolong, 1985). Huang and Hinze (2003) supported these observations from earlier research when they reported that one-third of accidents in the construction industry were due to workers misjudging potentially hazardous or dangerous situations. Another study in the construction industry reinforced these findings when authors indicated that poor training and enforcement of safety protocols, poor hazard recognition skills, poor attitudes toward a safety culture, and not using the appropriate PFAS increased the risk of accidents (O'Toole, 2002).

According to more recent findings, the telecommunication construction industry continues to face many of the same safety challenges, including poor attitudes toward the safety culture, hazard recognition skills, and the use of personal fall protection equipment. These issues are often aggravated by inadequacies in training and enforcement of safety protocols and failure to wear personal protective equipment (PPE), which can lead to a higher risk of injuries and accidents (Ammad et al., 2021; Chellappa et al., 2021; Giri, 2020; Khairudin et al., 2021; Meng & Chan, 2021).

These theories and empirical findings illustrate that workers' perceptions or risk behaviors may play an essential role in understanding why telecommunication technicians make their decisions in the execution of their work, wherein the unthinkable may occur. Given this information, it is also reasonable to assume that one would choose the actions that have the most desirable benefit. Understanding fatalities from this perspective may help industry participants enhance training, adjust incentives, and establish consequences to prevent injuries or fatalities and improve safety measures.

Over the last 40 years, falls have been a leading cause of death in the telecommunications industry and are a leading cause of accidents when working at heights (Abd Samad et al., 2023; Anantharaman et al., 2023; Firdaus & Erwandi, 2023). Factors conducive to such accidents include personal recklessness and low awareness, unsafe work practices, poor supervision, and human error (Anantharaman et al., 2023; Bussier & Chong, 2022; Firdaus & Erwandi, 2023). Telecommunications work is hazardous if not performed correctly, and if workers and companies do not adhere to the safety guidelines set forth by OSHA and the industry itself, it is almost certain that fatalities will continue. The OSHA standards specifically address telecommunications, construction, and general industry. Additionally, while not required by OSHA, other standards are also available for the industry through the National Association of Tower Erectors (NATE), the American National Standards Institute (ANSI), and the Telecommunication Industry Association (TIA) (OSHA, 2019). These industry best practices aim to reduce or prevent the number of injuries and fatalities that result from falls and other hazards in the telecommunications industry.

Despite the many safety regulations from OSHA and best practices of NATE, ANSI, and the TIA, workers are still experiencing accidents leading to injuries and fatalities. Understanding and following the regulations are of extreme importance and are to be part of conducting telecommunications work, especially given the nature of the work being performed at heights. The consequences of these accidents may be consequential and affect all stakeholders (Ellis, 2001; Health and Safety Executive [HSE], 2006) and include the loss of employee morale, financial hardships to not only the workers but the company, and psychological ramifications for colleagues and families.

The Evolution of Personal Fall Protection Standards

During the 1920s, workers were equipped with little more than loosely fitted body belts around the hips and fall hazard signs on job sites, thus leaving the responsibility squarely on the shoulders of the workers. In 1970, Congress approved the OSH Act of 1970 to ensure workplace safety (OSHA, 1970). By the 1970s and 1980s, OSHA took a more active role and began developing and enforcing fall protection standards for the transportation, mining, and construction industries (Fabenco, 2019). These standards created a paradigm shift in which employers were held accountable for fall protection safety. With the OSH Act, OSHA regulators conducted unannounced inspections, exacting fines and subsequently incurring costs for unsafe workplaces (OSHA, 1970). Over time, changes occurred in which employers in construction and other industries self-mandated passive protective measures such as guardrail gates and active measures such as body harnesses and ropes as basic fall protection measures to ensure worker safety (Fabenco, 2019).

In 1992, the American National Standards Institute (ANSI), a nonprofit organization in workplace safety, introduced the ANSI/ASSE Z359.1 American National Standard for personal fall arrest systems in non-construction occupations. The Occupational Health and Safety Administration followed suit two years later with the passage of the 1926 Subpart M standard, which mandated employers to provide fall protection to workers where employees in any industry were to be "tied off" at any height beyond six feet from the working surface (OSHA 29 CFR §1926.502). The ANSI Z359 fall protection standard was updated in 1999 and 2007, including individual standards narrower in the scope of the fall protection code (ANSI/ASSE Z359.0-2007, 2007). Then, in 2016, ANSI split the Z359 standard into smaller individual standards to clarify the nuances of specific fall protection elements compared to the original Z359 standard (Fabenco, 2019). Even when workers follow performance and consensus safety standards, often, the worker is to blame when something on the worksite goes awry.

Assumed Employee Risk

As with any industry, safety standards are important as they protect the worker and the company from needless injuries and preventable fatalities. Specifically, in telecommunications construction, a fall from heights is the foremost threat to technicians. Per regulations, any worker exposed to a height higher than six feet must utilize a personal fall arrest system (PFAS) provided by the employer (OSHA 29 CFR §1926.21 & §1926.503). Additionally, regulations mandate employers to provide workers with fall protection and PFAS training every two years (OSHA 29 CFR §1910.30). As falls are one of the foremost reported reasons for injury or death, understanding the components of PFAS is paramount. When a worker fails to utilize PFAS properly, or employers do not provide PFAS as mandated by OSHA, the risk of injury or death increases significantly (Giri, 2020). A PFAS includes a full-body harness, the connecting subsystems, and the ability to withstand 3, 600 pounds of force should a fall occur (OSHA 29 CFR §1926.503). Additionally, if a trained worker knows how to employ PFAS properly but chooses not to do so, the paradigm shifts from training or training frequency (Laird, 1985) to his/her decision to willingly forgo the use of the PFAS and required mandates (Blumberg & Pringle, 1982). Consequently, accidents and fatalities may result from this disregard; hence, an examination into fatalities may stop blaming the worker and not progress to other possible contributory issues that may lead to the actual root cause.

Telecommunications Technician Fatalities

Workplace accidents often result in the loss of life and money. In 2020, 4, 764 workplace accidents resulted in death (Bureau of Labor Statistics [BLS], 2021), a 10.7% decrease from 2019. This statistic equates to a worker death every 111 minutes across the United States, or a fatal work injury rate of 3.4 per 100, 000 full-time equivalent workers, down 0.1 from 2019 (BLS, 2021). The construction sector remains second, just behind transportation and warehousing, with 976 deaths (20.48%). Additionally, the leading causes of deaths in workplace fatalities are falls (17%) and contact with objects/equipment (15%), both prevalent causes within the specialty telecommunications construction sector (BLS, 2021).

In 2020, the telecommunications construction industry reported eight fatalities,.8% of all construction deaths. While this may seem small and insignificant compared to the entire construction industry, one life lost is, arguably, too many. Only a small handful of researchers have investigated accidents or fatalities resulting from falls from telecommunication towers (Hester & Fusch, 2020; Landa, 2013, 2014). Although telecommunication technicians make up a small percentage compared to other construction sectors and industries, that does not mean investigations into the causes of death are not warranted, should be abandoned or limited.

1.4 State Hypotheses and Their Correspondence to Research Design

The following research questions guided this study.

1) What are the contributory cause (s) of employee fatalities resulting from working at elevation on telecommunication towers?
2) To what extent, if any, has there been a difference in the number of fatalities in the telecommunications construction industry since PPE was mandated by OSHA in 1994?

2. Method

A quantitative descriptive design was used with archival data to determine the contributory cause (s) of employee fatalities resulting from working at elevation on telecommunication towers. Data from OSHA fatality summaries from January 1, 1984, through December 31, 2020, in OSHA's Integrated Management Information System (IMIS) were mined, collecting data from the following variables: year of the accident, whether PPE was mandatory, age and gender of climber, whether the climber was at fault and other factors that may have contributed to the fatality including, equipment, engineering, structure, rigging, ground crew, other, and unknown.

2.1 Identify Subsections

Data Collection Procedures

The fatalities within the study period included only workers whose regular work activities occurred higher than six feet above ground level on a telecommunications structure or a structure where telecommunications work was being performed, and the worker was killed during their daily work activities. For this study, we defined contributory factors as contributing to the technician's death separate from the use of the personal fall arrest system (PFAS). Researchers did not include fatalities in 2021 or 2022 as OSHA investigations may not be finalized, and the summary data is unavailable or incomplete. The data collected for this study was mined directly from either the OSHA summaries provided online or the actual OSHA files obtained by the authors. All summaries are readily available to the public if one has a summary number, inspection number, report, or accident identification number. All full OSHA reports obtained were done so by filing a Freedom of Information Act request through the appropriate OSHA office that investigated the fatality. In some cases, the files were lost or destroyed by OSHA facilities, which left investigators to rely solely on the IMIS summaries.

Once collected, the researchers mined data regarding the cause of death, interpreted the summary reports as written by the OSHA fatality investigators, checked mined data for errors, consulted industry and OSHA experts where needed for clarity on summary reports, and cleaned data. Researchers then coded the data and placed it into SPSS for analysis. Specifically, researchers collected data from the summaries, including:

- The year of the fatality.

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- If during the year the fatality occurred if PFAS was a mandated requirement.
- Age of the technician.
- Gender of the technician.
- The reason for fatality.
- Based on the summary, the technician was deemed at fault.
- Whether the worker was 100% secured to the structure during the execution of their duties according to the safety standards in fall protection.
- If there was a contributory factor to the fatality, including documented reference to the *engineering* of the structure, an issue with the *structure* itself, *equipment* used in the execution of the worker's duties (PFAS or other site equipment), an issue with the *rigging* on the job site, an issue with other workers on the job site such as ground workers or *equipment operators*, other factors, or a contributory cause of an *unknown* nature, and the amount of the fines assessed to the employer regarding the fatality.

Interpretation of OSHA Summaries

All the data for this article are preliminary. The information contained herein directly results from reading, studying, and interpreting the information given in the OSHA investigation summaries or full OSHA file. All summaries are readily available to the public if one has a summary number, inspection number, report, or accident identification number. Summaries were not consistent across OSHA locations or investigators; some summaries were very sparse with information or detail, while others provided a more robust picture of the events leading up to the fatality. It should be noted that we did not have a full OSHA file for each fatality. However, even when consulting full OSHA files for the incidents available, information was often unreadable for a myriad of reasons, including handwriting, redaction, knowledge of the investigator, and information provided by the parties involved. Very rarely is a fatality within telecommunications investigated by someone familiar with the nuances of the industry or scope of work provided by technicians in the field; often, investigators may rely on information provided by the employers, employees, and or third-party companies who advise companies after a fatality has occurred (personal communication, Rod Julian, 2022).

In extrapolating information from the OSHA summaries, we consulted with industry experts for information when the information, in summary, was unfamiliar or deemed industry-technical and beyond our scope of training or understanding. Two experts have been field technicians and now serve in safety management positions; they have 42 combined years of experience. The third expert has 40 years of experience, has worked in the field as a technician, and is a former fatality investigator at an OSHA state plan. To ensure we accurately interpreted each fatality summary with the most clarity possible, we recorded the exact phrasing from the fatality summary into the database. If unclear or even remotely unsure of the direct cause as reported or possible contributory factors, one or more of our three experts reviewed the summary and our coding for accuracy.

In several summary reports, the investigator may have reported one cause for the fatality, but there may have been underlying causes that were not apparent in reporting the fatality. For example, one such summary stated that the employees were "riding up on gin-pole derrick as it was being raised. Something at the top of the derrick popped/broke, allowing the gin pole to fall away from/off the tower. Both employees fell and were killed." We would have coded this reason for the fatality as merely "riding the line/gin/load" as the employees were not secured to the structure itself with PFAS (they were hoisted up the tower, not climbing the structure itself). However, several things may have contributed to the fatality, including rigging or ground crew error as part of the equipment presumably failed ("something at the top of the derrick popped/broke, allowing the gin pole to fall away from/off the tower"); this could have been defective equipment or the ground crew making an error in which equipment to use. It was unclear in this case, as with many others, what happened specifically to cause the fatality. In such cases, our experts reviewed these summaries and files to provide us with a complete picture of the events. Subsequently, we coded "riding the line/gin/load" as the reason for fatality but also coded the technician as partially at fault for riding the line (which is only allowed under certain circumstances, and from the file, we were unable to determine if this was such a case). We coded contributory factors as "rigging" and "groundcrew" as possible contributory factors.

Coding Variables

The coding of variables extrapolated from the summaries corresponded to the nature of the data collected. Data for "reason for accident" were initially coded as 1 = Equipment. Malfunction, 2 = Free Climbing, 3 = Electrocution, 4 = Fall, 5 = Tower Collapse / Tower Fell, 6 = Riding the line, gin, or headache, 7 = External Causes, 8 = Improper Rigging, 9 = Crushed, 10 = Fall from ground equipment, 11 = Suffocation, 12 = Other, and 13 = "Struck by object." Similarly, data for whether or not it was the technician's fault for the fatality were coded as 1 = Yes, 2 = No, 3 = Undetermined, and 4 = Partially. The coding to contributory factors were coded as 0 = No contribution, 1 = Equipment, 2 = Engineering, 3 = Structure, 4 = Op-Ground Crew, 5 = Rigging, 6 = Other, and 7 = Unknown. Additionally, there were codes ranging from 8-17 that were combinations of the specific contributory causes that appeared throughout the dataset. Lastly, dummy variables were created to control for contributory factors (i. e., if only rigging contributed to the accident, the rigging dummy variable was coded a 0, while the other contributory variables were coded a 0).

3. Results

To address Research Question 1, frequencies and descriptive statistics were examined to determine the contributory causes of telecommunication tower fatalities. Based on data reported by OSHA from 1984 to 2020, 62.6% of fatalities were attributed to climber's fault; 12% were partially attributed to climber fault. Table 1 provides other factors that contributed to tower fatalities. Although 48.3% of fatalities had no contributing factor other than climber fault, 8.9% were also attributed to rigging. Other or unknown factors contributed to 10.9% of fatalities and consisted of falls (60.6%); tower collapse (10.4%); "riding the line or gin" (6.2%); electrocution (3.2%); crushed (2.2%); improper rigging (1.2); struck by an object (.7%); and fall from ground equipment (.5%).

Table 1: Contributing Factors to Communication Tower Fatalities

Factor	Frequency	Percent
No other contributing factor	195	48.3
Equipment	12	3
Engineering	3	0.7
Structure	18	4.5
Operations-Ground Crew	16	4
Rigging	36	8.9
Other/unknown	38	10.9
Equipment and rigging	13	3.2
Equipment and groundcrew	9	2.2
Groundcrew and rigging	2	0.5
Rigging and other/unknown	2	0.5
Rigging structure	3	0.7
Structure engineering	1	0.2
Structure equipment	1	0.2
Structure groundcrew	1	0.2
Total	**350**	**100**

Note. Workplace factors that contributed to workplace fatalities from 1984 to 2020.

To address Research Question 2, a Mann-Whitney U test was conducted to determine the difference in the number of telecommunication tower fatalities since PPE was mandated by OSHA in 1994 and before the OSHA mandate. There were no significant differences in telecommunication tower fatalities between mandated PPE and non-mandated [U = 9904.50, p = 1.00]. Figure 1 shows the results of the Mann-Whitney U test. It should also be noted that the data obtained prior to the OSHA mandate only consisted of seven years, whereas the data following the mandate consisted of 18 years.

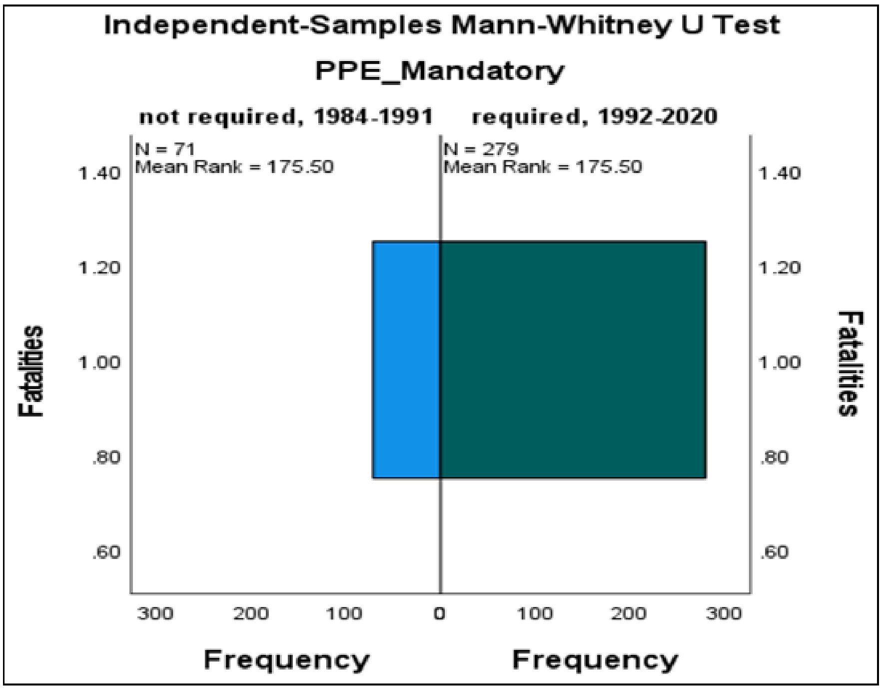

Figure 1: Independent Samples Mann-Whitney U Test

Note. The number of telecommunication tower fatalities by year.

Figure 2: Years of Telecommunication Tower Fatalities

		Fatalities	Total
Year	1984-1990	51	51
	1991-1997	59	59
	1998-2004	106	106
	2005-2011	68	68
	2012-2018	50	50
	2019-2020	16	16
Total		350	350

Note. Breakdown of fatalities by year groupings.

4. Discussion

The results of the study illuminate the influential causes of fatalities in the telecommunications construction industry, as well as the impact of OSHA's Personal Protective Equipment (PPE) mandate in 1994. Our findings indicate that a significant proportion of fatalities (62.6%) were credited to climber error. Of these, 62.6% and 48.3% were due to climber error, and 8.9% were attributed to rigging issues. These findings indicate essential areas for targeted interventions, comprehensive safety measures, training, and safety protocols in both practice and further research endeavors. Additionally, these findings also warrant additional attention to both climber practices and rigging procedures.

Furthermore, the different periods examined in this study showed variations in the number of incidents, with peaks observed in certain years. Notably, there were no significant differences in fatalities between periods before and after the implementation of the PPE mandate by OSHA, which underscores the importance of continual evaluation and enhancement of safety practices beyond mere regulatory compliance. Furthermore, the finding also indicates that while the PPE mandate is helpful and indeed essential, the mandate alone may not be enough for fatality reduction; this also emphasizes the need for comprehensive approaches to how safety management approaches work in the field.

5. Limitations

The limitations of this study include an uneven comparison between the period examined, inconsistent OSHA report data, and an inability to examine all of the fatality files between 1984 and 2020. These limitations suggest a need for further, more granular data to better understand the underlying causes of fatalities. There remains a need for ongoing research efforts striving to provide data and actionable suggestions for telecommunication workers and other industry stakeholders.

6. Recommendations

Several recommendations have emerged from this descriptive study, including a more active approach to changing the safety culture within the telecommunications industry. Accountability of responsibility, more effective training methods, and implementing targeted interventions for climber safety are recommended for areas of exploration. It is recommended that studies strive to approach studies both from a data-driven perspective as well as from a holistic perspective, utilizing both qualitative and quantitative studies, moving forward. By expanding the research and digging into the available data at a more granular level, the telecommunications and construction industries may be able to continue mitigating risks to the worker while also advancing safety outcomes.

Delimitations

This study is limited to examining fatalities and the contributory causes. The study is descriptive and narrow in scope, examining only those accidents investigated by OSHA and documented in the IMIS database from 1984 through 2020. It is limited to files that can be retrieved from OSHA FIOA requests by the authors.

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Appendix

Example of OSHA Summary

Accident Investigation Summary

Summary Nr: 200150746 Event: 01/27/2003 Employee Killed In Fall From Cell Tower

At approximately 2:50 p.m. on January 27, 2003, Employee #1, of IMC Antenna & Tower Company, was working on a 132 ft monopole located at a site in Syosset, NY. He was climbing the tower when he fell about 84 ft and was killed. Although the cause of the accident has not been determined, several contributing factors have been identified: (a) equipment failure—Employee #1 used a wire rope grab to ascend the monopole to where a new platform was being installed. According to witnesses, he bent over and leaned to his left for some known reason before he was able to connect to his lifeline. The wire rope grab separated at that point when the rivets holding the braking mechanism pulled out under a side load; one part was found 30 ft away from the tower and the other part was found on the ice bridge just below the lower anchoring point of the safety climb; (b) wire rope—the 3/8 in. wire rope, know as the safety climb, may have been installed upside down so that it was not convenient for climbers to take slack out of the line. A witness claimed there was excessive slack in the line, which may have allowed Employee #1 to put a side load on the rope grab when he bent over; (c) weather—on the day of the accident, there was snow on the ground, it was windy, and the temperature was 11 degrees F., with an average wind of 20-25 knots at the 100 ft elevation and a wind chill factor estimated at between (-) minus 11 degrees F. and (-) minus 15 degrees F; (d) carabineer—Employee #1 apparently installed a large aluminum carabineer in addition to a small black carabineer that was attached to the wire rope grab and the safety climb; this combination extended the distance between his chest D-ring and the wire rope beyond the 9 in. required under OSHA's Construction Standards. *Fall distance.*

Keywords: construction, communication tower, fall, communication worker, equipment failure, wire rope, frozen, fall protection, tower

	Inspection	Degree	Nature	Occupation
1	304681026	Fatality	Concussion	Occupation not reported