

**FACE****Fatality Assessment and Control Evaluation Program**

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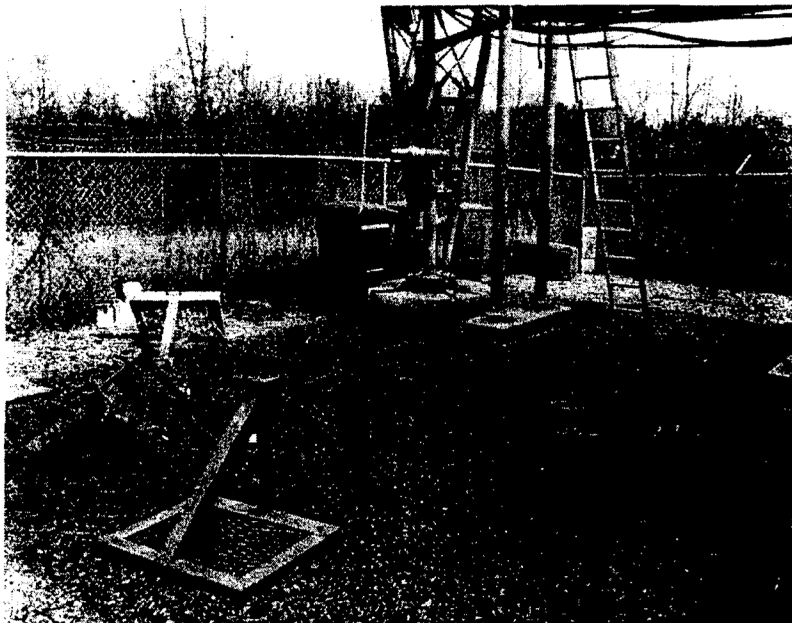
March 16, 2000

Three Tower Painters Die After Falling 1,200 Feet When Riding the Hoist Line – North Carolina

PB2000-107343

**SUMMARY**

A 40-year-old tower-painting-company owner, his 16-year-old stepson, and a 19-year-old employee died after falling 1,200 feet when the hoist line on a portable capstan hoist used to raise them up the side of a 1,500-foot-high radio tower began slipping around the capstan, causing the hoist operator to lose control of the hoist line. The company had been at the site for 2 weeks to repair the beacon light at the top of the tower, paint the tower, and install rest platforms

*Incident Site*

on the tower. On the day of the incident, the owner was going to work on the beacon light at the top of the tower while the two other workers were going to continue painting the tower. A 3,000-foot length of $\frac{3}{4}$ -inch nylon rope and a 1,000-pound-capacity portable electric capstan hoist was used to raise the male workers up the outside of the tower. Three loops, which the workers utilized to assist them in riding the hoist line, were tied into the hoist line approximately 6 feet apart. The stepson was first on the line, then the 19-year-old, then the company owner. Using a length of woven rope, the male workers had attached one of the rest platforms to the end of the nylon rope 62 inches below the

Fatality Assessment and Control Evaluation (FACE) Project

The National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR), performs Fatality Assessment and Control Evaluation (FACE) investigations when notified by participating states or the Wage and Hour Division, Department of Labor. The goal of these evaluations is to help prevent fatal work injuries in the future by studying the working environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

States participating in this study: North Carolina, Pennsylvania, South Carolina, Tennessee, and Virginia.

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last loop. The company owner's wife was operating the capstan hoist using a foot pedal located on the ground. As the wife was operating the hoist and hoisting the men up the side of the tower, the hoist line began to slip around the capstan. The wife tried to hold the rope, but could not and the men fell to the ground. The wife went to the tower's service building and called the radio station that owned the tower, who in turn told her to call 911. The owner of the company that maintained the county equipment attached to the tower was in his truck and heard via radio that the county emergency medical service had been dispatched to the scene. He proceeded to the scene and was the first responder to arrive. The county fire rescue squad arrived next, then the county emergency medical service. Due to the extent of the victims' injuries, no first aid was initiated. After the county sheriff's personnel secured the scene, the victims were taken to the local hospital, where they were officially pronounced dead. NIOSH investigators concluded that to help prevent similar incidents, employers should:

- *ensure that hoisting equipment used to lift personnel is designed to prevent uncontrolled descent and is properly rated for the intended use*
- *comply with OSHA Compliance Directive CPL 2-1.29 "Interim Inspection Procedures During Communication Tower Construction Activities" during maintenance and construction activities on towers*
- *ensure that workers inspect equipment on a daily basis to identify any damage or deficiencies*
- *ensure that required personal protective equipment is available and properly used*
- *know and comply with child labor laws which include prohibitions against work by youth less than 18 years of age in occupations which are declared by the Secretary of Labor to be particularly hazardous (Hazardous Orders).*

Additionally: Tower owners should ensure that workers adhere to OSHA Compliance Directive CPL 2-1.29 while performing maintenance or construction activities on their towers.

INTRODUCTION

On December 3, 1999, a 40-year-old tower-painting-company owner, his 16-year-old stepson, and a 19-year-old employee died after falling 1,200 feet when the hoist line on a portable capstan hoist used to raise them up the side of a 1,500-foot-high radio tower began slipping around the capstan, causing the hoist operator to lose control of the hoist line. On December 7, 1999, officials of the North Carolina Occupational Safety and Health Administration (NCOSHA) notified the Division of Safety Research of this multiple fatality. On December 21 through 23, 1999, a DSR occupational health and safety specialist conducted an investigation of the incident. The incident was reviewed with the NCOSHA compliance officers assigned to the case, the tower owner's engineering services representative, the owner of the company that maintained the county's hardware on the tower, the owner of the company that installed the new coaxial cable, the county coroner, and the county sheriff's office. The site was photographed and photographs and video footage taken immediately after the incident were reviewed. The county coroner and sheriff's reports were reviewed during the investigation, as well as site drawings and sheriff's department photographs taken immediately after the incident. An engineer and the manager of the proprietary properties department for the hoist manufacturer were consulted on questions pertaining to the operation of the hoist, and manufacturer's literature and catalogues pertaining to the hoist were reviewed. Correspondence prepared by a manufacturer's engineer to answer the NIOSH investigator's questions was provided by the manager of proprietary properties.

The company was a family-owned tower painting and maintenance service. The owner's brother stated during OSHA interviews that the owner had over 20 years experience painting and performing maintenance on towers. At the time of the incident the company owner had three employees - his wife, his 16-year-old stepson, and a 19-year-old male employee. The company had no written safety policy or safety program. Any training was performed on the job. Although the owner's wife stated that she, her son and their employee had worked with her husband on numerous occasions, the amount of tower-related work experience could not be determined at the time of the investigation.

INVESTIGATION

The company had been contacted by a radio station to install a new coaxial cable for the radio broadcast antenna on the station's 1,500-foot-high, three-sided telecommunication tower, and to replace the beacon light at the top of the tower's antenna. After the cable installation was complete, the company was to paint the tower and install rest platforms at designated intervals up the tower. The company owner, his 16-year-old stepson, and a 19-year-old male employee were performing the work.

The owner had recently purchased six, 500-foot lengths of ¾-inch diameter nylon rope that he spliced together to use as the hoist rope on this job. He had also rented an 8,000-pound capacity powered cable puller to raise the coaxial cable up the tower. After setting up the cable puller and replacing the beacon light at the top of the antenna, the male workers attached the coaxial cable to the hoist line and began raising the cable up the inside of the tower structure. The cable had been raised approximately 300 feet when the director of engineering services for the radio station arrived at the site and instructed the owner to lower the cable back down the tower. It was determined that the company did not have sufficient equipment or manpower to install the cable but would still paint the tower and install the rest platforms. A second contractor was then contracted to install the coaxial cable.

When the cable had been installed by the second contractor, the company began to paint the tower. The owner attached a portable electric capstan hoist to the tower approximately 6 feet above ground level (Figure 1). An extension cord was plugged into a 115-volt outlet in the tower's adjacent

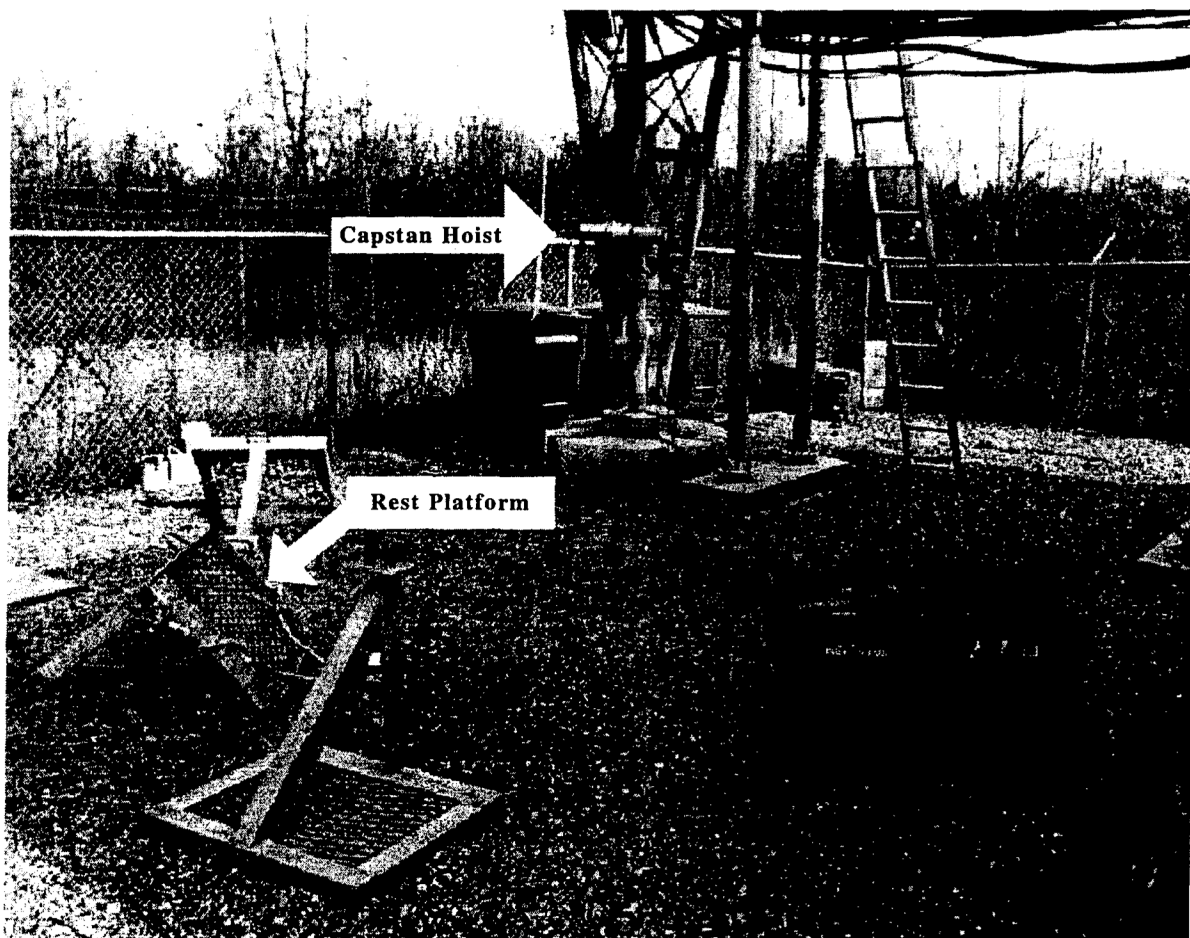


Figure 1. Incident Site

service building to power the hoist. Power to the hoist was controlled by a foot switch that was activated by stepping on the switch. The portable electric capstan hoist had a lifting capacity of 1,000 pounds and was not manufactured or rated for lifting people.

For safe operation and positive control of the load being lifted the capstan is designed to turn in only one direction. The proper method of wrapping the hoist rope around the capstan will place the "load wrap" (the end of the rope attached to the load) on the inboard end of the capstan where the diameter is the smallest (Figure 2).¹ This allows the rope to feed smoothly over the capstan without jumping or changing position. The number of rope wraps around the capstan is determined by many variables including the load to be lifted. The final determination is made by "feel." "Feel" is defined by the manufacturer as the amount of force required to keep the rope just tight enough around the capstan to raise or lower a load. With the proper number of wraps, an approximate 20-pound pull should raise or lower a load. Adding wraps of rope around the capstan decreases the amount of pull required to control the load. Removing wraps increases the amount of pull required.¹

The workers painted for several days and used the hoist line to assist them in climbing inside the tower. To prevent the rest platforms from striking the tower while being raised, the owner climbed the tower and rigged the hoist line so that the load line would be on the outside of the tower structure on Thursday, December 2, 1999. The owner had been notified earlier that day by the radio station that owned the tower that the beacon light at the top of the tower was again not working.

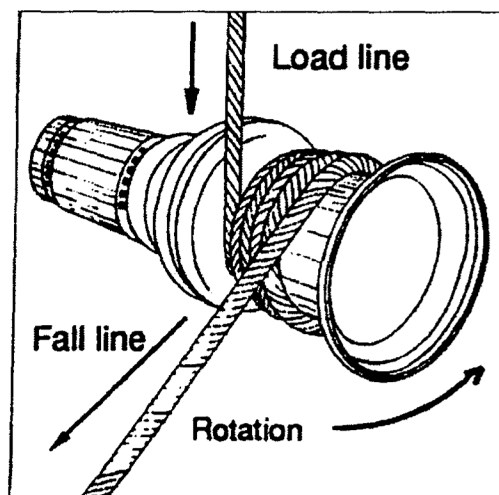


Figure 2. Proper method for wrapping the hoist rope around the capstan for optimum rope action

The three workers arrived at the site the following morning, along with the owner's wife. It was decided that the two younger workers would continue painting while the owner worked on the malfunctioning beacon light and installed one of the rest platforms. The male workers intended to ride the hoist line to their work stations. The two painters would be raised to approximately the 1,200-foot level where they would step onto the tower, while the owner would ride the line to the top of the tower.

The male workers tied one end of a length of $\frac{1}{2}$ inch woven rope to one of the rest platforms, then tied the other end to the end of the hoist's load line. The rest platforms were approximately $2\frac{1}{2}$ -feet square and weighed approximately 175 pounds. Three loops were tied into the hoist load line approximately 60 inches apart to assist the workers in riding the line. The three workers then used a stepladder to climb to the first crossbar on the tower, and the wife was instructed to begin raising the hoist line and rest platform. Evidence suggests that as the loops reached the workers, the workers stepped into them. The owner's stepson was first on the line, then the 19-year-old employee, then the owner. As the male workers were raised, the owner's wife kept pressure on the hoist line by pulling the rope (fall line) from the capstan hoist, allowing it to fall to the ground.

The male workers were raised without incident until they reached approximately the 1,200-foot level. At that time, the rope began to slip around the capstan and the wife lost control of the hoist line. She tried to hold the line but could not. She looked up to see the three male workers falling. They fell to the ground, landing approximately 60 feet from the tower (Figure 3). The wife ran to the tower's service building and called the radio station that owned the tower. The station personnel

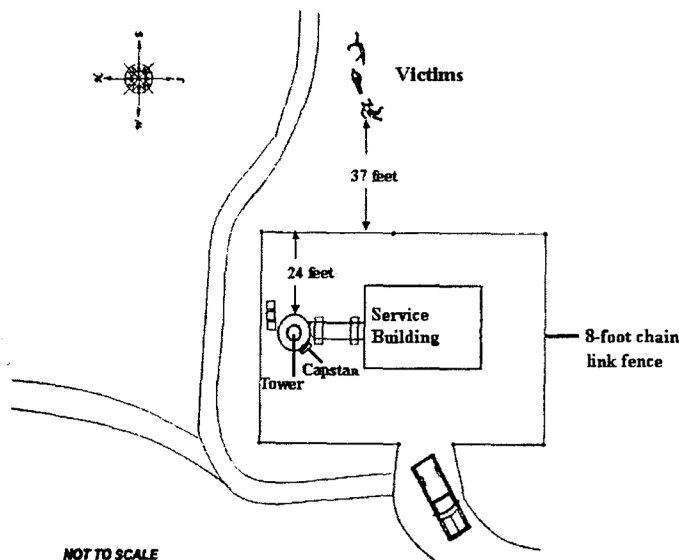


Figure 3. Overhead view of the incident site

instructed her to call 911, which she did. The owner of the company that serviced the county's hardware on the same tower heard the Emergency Medical Service (EMS) dispatched to the tower over the radio in his truck and proceeded to the tower. The fire rescue squad and EMS were next on the scene and checked the victims for vital signs, but found none. The owner's wife was transported to the hospital where she was treated for shock and rope burns to her hands. When the scene had been secured by sheriff's department personnel, the victims were transported to the hospital where they were officially pronounced dead.

As previously mentioned, the hoist was not rated for lifting personnel. It is also possible that the hoist was being used in an overload condition. The weights of the 3 victims, as obtained from the county coroner were 190, 200, and 210 pounds. The weight of the rest platform was 175 pounds. The hoist manufacturer's braided rope, similar to that used in this incident, weighs 14 pounds per 100 feet in length.² The weight of at least 2,000 feet of rope was against the hoist at the beginning of the lift. This would have added an additional weight of 280 pounds ($2,000 \times .14 \text{ lb/ft} = 280 \text{ lb}$). The total of these weights would be 1,055 pounds. An additional load on the hoist would have been the friction added by the pulley at the top of the tower. A manufacturer's engineer stated that it is usual to add a minimum of 10% (105 lbs) additional load for this friction. It is possible that the capstan could have seen a total load of 1160 pounds, exceeding its 1,000 pound capacity.²

It could not be determined why the rope began to slip around the capstan. The fact that it slipped indicates that not enough force was being applied to keep the rope tight around the capstan. The owner's wife stated that she had operated the hoist a few times in the past but never with men on the line. She also said she thought the capstan was full of rope wraps. The hoist manufacturer's literature indicated that, under tension, 8 complete wraps of 3/4-inch braided rope could be placed on the hoist drum and would completely fill the drum.² As a general rule, 3 or 4 wraps would allow an operator to lift the rated load of 1,000 pounds with 20 to 40 pounds of pull on the fall line. -Figure 4 contains the manufacturer's chart used to calculate the required fall line pull for a load with 1 to 5 wraps of rope on the hoist drum.³ Following the line to the right of the number 4 (number of wraps located on the left side of the chart) to the intersection of the curve, then down to the bottom shows that 4 wraps yield an approximate 44:1 mechanical advantage. In this case, a 44:1 advantage is $1,160 \text{ lb}/44 = 26.26$ pounds of pull required on the fall line to lift the load. Using the same procedure, it can be seen that 5 wraps yield an approximate 115:1 mechanical advantage. In this case, a 115:1 advantage is $1,160 \text{ lb}/115 = 10.08$ pounds of pull required on the fall line. If the hoist drum was full of 8 rope wraps, the pull required would be less.

The 3/4-inch nylon rope used was the maximum diameter suggested by the manufacturer for use on the

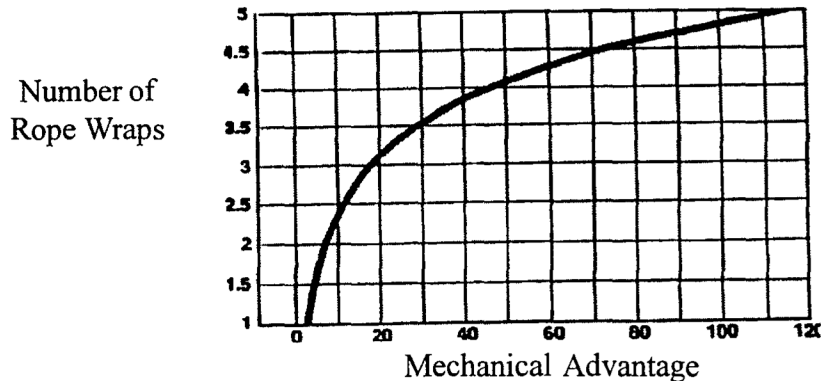


Figure 4. Mechanical Advantage of Series 90 Hoists

portable capstan hoist. As previously mentioned, the six 500-foot sections of rope were spliced together. The diameter of one of the spliced areas was approximately 1 $\frac{3}{8}$ inch. It is not known if the difference in diameter of the rope wraps on the capstan could have been a factor in the incident. Correspondence with one of the hoist manufacturer's engineers indicates that most splices, although larger in diameter than the rope, will move across the capstan smoothly. However, unusually large splices may tend to "over wrap" the rope already on the capstan. This "over wrapping" would require the hoist operator to momentarily reduce the pull on the fall line rope to allow the splice to seat on the capstan.²

CAUSE OF DEATH

The county coroner listed the cause of death for all three workers as massive trauma.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Employers should ensure that hoisting equipment used to lift personnel is designed to prevent uncontrolled descent and is properly rated for the intended use.

Discussion: The hoist used in this incident was not rated for the transport of personnel, and warning labels on the hoist stated that the hoist was not intended for use in the lifting or moving of persons. Equipment should only be used as rated by the manufacturer. OSHA Compliance Directive CPL 2-1.29, *Interim Inspection Procedures During Communication Tower Construction Activities*, requires that hoists used to lift personnel must be designed to use power lowering;⁴ the hoist in this incident was not. Additionally, CPL 2-1.29 requires that hoists used to lift personnel be equipped with a primary brake connected directly to the drive train of the hoisting machine and a secondary automatic emergency-type

brake that, if actuated, would be able to hold the rated load within a vertical distance of 24 inches.⁴ The hoist involved in this incident was not equipped with a braking system.

Recommendation #2: Employers should comply with OSHA Compliance Directive CPL 2-1.29 during maintenance and construction activities on telecommunication towers.

Discussion: OSHA Compliance Directive CPL 2-1.29 describes measures to be taken during the construction of telecommunication towers.⁴ To ensure the safety of workers, these measures should also be applied to maintenance activities. The directive outlines measures including, but not limited to, access of towers using hoists, requirements for hoists, 100% fall protection, the training of hoist operators, and the inspection of equipment components. The Compliance Directive outlines the proper methods for riding the line and transitioning from the hoist line to the tower. Had these measures been followed in this incident, these fatalities may have been prevented.

Recommendation #3: Employers should ensure that required personal protective equipment is available and properly used.

Discussion: OSHA Compliance Directive CPL 2-1.29 and 29 CFR 1926.502(d) require the use of a body harness as a personal fall arrest system.^{4,5} In this instance, two of the victims were wearing body harnesses but the leg straps were not fastened. The owner was wearing only a safety belt. Personal protective equipment (PPE) was not a factor in this incident; however, to provide the safest possible work environment, employers should ensure that the proper PPE is available and utilized in the correct manner.

Recommendation #4: Employers should ensure that workers inspect equipment on a daily basis to identify any damage or deficiencies.

Discussion: All equipment shall be visually inspected by a qualified person,[^] as defined by the OSHA Compliance Directive CPL 2-1.29, on a daily basis before work begins.⁴ In this instance the lanyards used by the workers were worn and frayed and the hoist rope was spliced in several places and was very worn and abraded, with several areas repaired with plastic tape. Both the workers' lanyards and the hoist

[^]Qualified person: One who, by possession of a recognized degree, certificate or professional standing, or who by extensive knowledge, training or experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work or the project.

rope should have been removed from service. Although the condition of this equipment was not a factor in this incident, equipment should be inspected on a daily basis to identify damaged or deficient equipment. Once this equipment is identified, it should be removed from service, thus eliminating the exposure of workers to hazards.

Recommendation #5: Employers should know and comply with child labor laws which include prohibitions against work by youths less than 18 years of age in occupations which are declared by the Secretary of Labor to be particularly hazardous (Hazardous Orders).

Discussion: The Fair Labor Standards Act provides a minimum age of 18 years for work which the Secretary of Labor declares to be particularly hazardous (Hazardous Orders). One of the 17 Hazardous Orders prohibits minors from work in all occupations involved in the operation of power-driven hoisting apparatus, including riding on a manlift (Hazardous Order No. 7).⁶ The term “manlift” is defined as “a device intended for the conveyance of persons which consists of platforms or brackets mounted on, or attached to, an endless belt, cable, chain, or similar method of suspension; such belt, cable, or chain operating in a substantially vertical direction and being supported by and driven through pulleys, sheaves or sprockets at the top and bottom.”

Additionally: Tower owners should ensure that workers adhere to OSHA Compliance Directive CPL 2-1.29 while performing maintenance or construction activities on their towers.

Discussion: The widespread use of wireless communication services has fueled the demand for construction, and subsequent maintenance, of towers to hold transmitting devices for radio and television broadcast antennas, personal communication services and cellular phones. Recent NIOSH FACE investigations indicate that many employers, supervisors, and workers may not be fully aware of the serious fall hazards associated with tower work. Problems identified include, but are not limited to, lack of employer safety programs, use of improper PPE, improper use of PPE, lack of worker training, and improper use of hoists to transport personnel up and down the tower. Because construction and maintenance operations may be accomplished in brief time periods, it is virtually impossible for OSHA to monitor the safety and health practices of the employers involved. For this reason, tower owners should become familiar with OSHA Compliance Directive CPL 2-1.29 which outlines safety measures to be taken during tower construction.⁴ These measures should also be adopted for maintenance activities. The tower owners should establish safety parameters as guided by CPL 2-1.29 to be followed for each job and monitor the work being performed on their towers. Tower owners may want to enlist the aid of professional engineers to establish the safety parameters. Scheduled and unscheduled

safety inspections should be conducted at the tower sites by designated persons, which would demonstrate the tower owners' commitment to safety and health and their desire to control the risk of occupational injury.

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INVESTIGATOR INFORMATION

This incident was investigated by Virgil J. Casini, Safety and Occupational Health Specialist, NIOSH, Division of Safety Research, Surveillance and Field Investigations Branch. Mr. Casini is with the NIOSH Fatality Assessment and Control Evaluation Program located in Morgantown, West Virginia.

ACKNOWLEDGMENT

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